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# The Risk Appetite of Pension Funds

## The Case of Canada

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## Chapter 1 Introduction

In all of western society, Pension systems are the cornerstone of care for the elderly. Pension systems provide the elderly with income and financial security for the future and occasionally health insurance. Pension spending in the EU occupies a huge part of total GDP spending. In some countries, for example in Italy, this can reach up to 14% of total national GDP spending according to the OECD pension databank. Pension systems, thus play an important role in government policy especially considering the aging trend we see in Europe. With all the money that has been funnelled in to pension funds, the pension market constitutes one of the largest investors in the world. The assets of the global pension market have surpassed the 24 trillion mark in 2013 (OECD, 2013). Some countries have amassed gigantic pension funds sometimes up to 166% of GDP in the case of the Netherlands.

However, not all Pension systems are the same. The classification for the Pension system mainly consists of 3 Pillars as classified by the World Bank. The first pillar is commonly referred to as the PAY-as you go system which  means that pensions paid to current pensioners are financed from contributions paid by the working now which are levied through income taxes. The second pillar mainly refers to the pension funds where the working class contribute their earnings, which is reinvested and handed over to the individual when they retire. The third pillar finally, refers to voluntary private funded accounts. Countries differ in how much focus is laid on each pillar. In the Netherlands, the second pillar is really strong in leading to pension funds amassed of over 166% of GDP while in other countries the second pillar is almost non-existent and the focus is mainly on the first pillar. In this thesis, the focus will be on the third pillar of the Canadian pension system. In Canada, the third pillar consists of occupational pension schemes for public or private workers which they can opt out of if they wish to do so. More specifically, the focus will be on the occupational schemes provided by the 100 biggest funds in Canada. To limit the focus of this research, this thesis looks only at the 100 biggest occupational pension funds in Canada.

The pension funds have the important task of investing the money given to them by their participants. The way their asset portfolio is constructed would depend on the risk appetite of the pension fund. Risk appetite can be defined as the ‘ willingness to take risks in order to meet strategic objectives’. In the pension fund context, we can proxy for risk appetite by looking at the equity share as explained in the life cycle theory (Pension funds can differ in their risk appetite), this leads to different asset allocation between pension funds as riskier pension funds would increase their equity shares as these give higher return but also carry more risk while funds that opt for a lower risk appetite would opts more riskless assets. It would be interesting to research what drives this difference in risk appetite (equity share) leading to the following research question:

*What drives the risk appetite (equity share) of Pension funds in Canada?*

The remainder of this thesis will begin with chapter 2  in which the concept of risk and its associated concepts such as risk universe and most importantly risk appetite for pension funds and its implementation by pension funds. Also, this chapter the proxy of equity share for risk appetite will be explained more in detail. Finally, at the end of chapter 2 the hypotheses to be tested will be described

Chapter 3 describes the Canadian pension system starting with the history of the system and explaining in detail the pillars on which the Canadian pension system stands. Also, this chapter contains statistics on the Canadian pension system. Finally, Chapter 3 provides some info on the investment regulations that Canadian pension funds face.

Chapter 4 contains the information on the dataset used and the statistical methods used to research the hypotheses mentioned in chapter 2.

Chapter 5 contains the results from our statistical analysis and chapter 6 has the conclusions based on our statistical analysis. Finally, chapter 7 contains the recommendations for future research.

# Chapter 2 Risk, Risk aversion, Risk appetite

## 2.1 What is Risk ?

Before we can talk about risk appetite, we need to have a clear understanding of what risk is. Risk is something that can be divided into several different types of risk. This is inherent with risk as it has different meanings for different types of people. This is even further exemplified by its official definition 'A probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action'. From this definition, we can already see that risk is not the same for everyone. For example, to a business manager, risk would be when the macroeconomic level of the economy goes down leading to lower sales and suppressed profits, while for an equity investor, risk is the downside volatility of this stocks. For pension funds, the term risk can enthral multiple types of risk, think of aging risk, downside volatility risk, interest rate risk and the list goes on. The common denominator in all these situations is that the decisions by the agent are made under uncertainty. Current economic theory divides uncertainty into two categories: (i) a non-measurable uncertainty and (ii) a measurable uncertainty. The first is known as the 'Knightian uncertainty' while the latter is known as risk. The key difference between the two is that risk is measurable as the probability distribution of the event occurring is known allowing it to be measured and quantified. In this thesis, we discuss the risk appetite of pension funds which interact on a market on which probability distributions are usually known except for extreme cases when the probability models fail.

We can further specify risk into 4 attributes on which we can assess risk. For every event that has risk, we can zoom in on the four attributes size, likelihood, impact and significance (Watson, 2013).The size of the risk refers to what the risk source is. The likelihood of the risk refers to probability of the event occurring expressed in a percentage. Impact is the direct effect of the event on the business of the fund. The significance means the direct consequences of the event but also the indirect or subsequent effects of the event.

## 2.2 Risk aversion

Before risk appetite can be defined, it would be wise to first discuss risk aversion as the concept of risk appetite is closely linked to risk aversion. Risk aversion was first described in economic literature in 1738 by mathematician Daniel Bernoulli. The theory behind Risk aversion comes from the paper "expected utility maximization of a concave utility of wealth function" (Rabin & Thaler, 2001) In this paper, Thaler and Rabin demonstrate risk aversion through a game in which participants have the option of a sure chance of winning 50 dollar or 50% chance of winning 100 dollar. Participants they showed could be divided in those who would take the sure chance of 50 dollars (risk averse) and those who took the gamble of 100 dollars (risk loving). We can define risk aversion by,' risk aversion is the behaviour of humans (especially consumers and investors), when exposed to uncertainty, to attempt to reduce that uncertainty'. The concept of risk aversion itself has been studied extensively in behaviour economics and neuro economics which in turn have led to the equity premium puzzle in which risk aversion is a central theme.

## 2.3 Risk appetite

We just introduced the concept of risk aversion, which begs the question, what is exactly the difference between risk appetite and risk aversion? The difference being that risk appetite can be seen as the practical application of risk aversion. According to Misina (2006), researchers still seem to think that risk appetite is a negative of risk aversion while risk appetite can be much more. So how do we define risk appetite? Some would say that risk appetite can be defined in a single variable that captures the risk appetite of the organization. One such variable could be the Chicago Board Options Exchange's Volatility Index (the 'Vix'). This is an expectation of market volatility aggregated from investor's expectation on volatility in the market. When Vix is high expected, volatility is high and investors face higher costs hedging the market risk. This definition of risk appetite would fit for a single equity investor but as the IRIM already notes there is no metric that sufficiently captures risk appetite.

The institute of Risk management (The Institute of Risk Management, 2011) defines risk appetite as the ' willingness to take risks in order to meet strategic objectives'. This definition of risk appetite translates to important decisions within in the pension fund asset allocation.

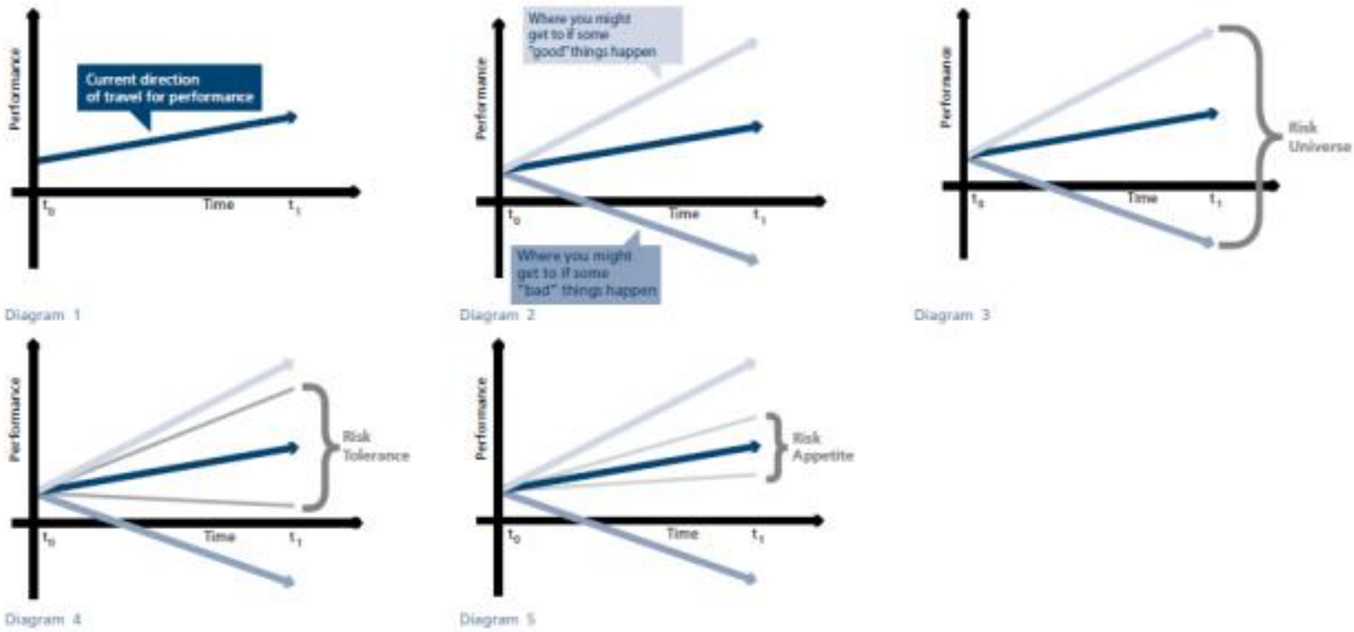


**Figure 1** (The Institute of Risk Management, 2011)

We can further explain the concept of risk appetite by comparing it to the concept of risk tolerance and the risk universe. Suppose we have a company whose performance is uncertain and follows a stochastic distribution. The range of all possible outcomes positive and negative can be seen in diagram 3 and is what we call the risk universe. According to the IRIM (2011), the risk tolerance lies within the risk universe that we just described. The risk tolerance can be described as the degree of variability that an investor is willing to withstand. When applied to pension funds, risk tolerance can indicate the maximum loss that the fund is willing to take. This maximum loss can differ depending on the asset class or other specifics. Risk tolerance is thus the outer limit of what the fund is willing to lose. Risk appetite, in contrast is seen as the amount of risk that the pension fund optimally wants to meet its investment objectives. The risk appetite is smaller than the risk tolerance as can be seen in diagram 5 (The Institute of Risk Management, 2011) .

## 2.4 Risk appetite in a pension fund setting

Pension funds bear great responsibility as they are the main source of income for elderly and seniors. This means that pension funds have to carefully consider how to invest the funds entrusted to them by their members. In a perfect setting, pension funds would only invest in risk free investments ensuring that that their members are provided for in the future. Unfortunately, risk free investments tend to deliver less than required returns. This means that pension funds have to take risks to achieve a higher return. This raises the question, 'what is the risk that pension funds are willing to take i.e. what is their risk appetite?'

In the pension fund setting, the board defines the risk appetite, this is done with the help of ALM studies and strategic advice from the fund. Muriel van der berg in her piece 'Guidelines to develop and implement a risk appetite for Dutch pension funds' give examples of which questions the board answers to develop the risk appetite (Van den Berg, 2013).

- Which nominal or real pension is pursued and with which level of certainty?
- What is the maximum loss (in funding ratio or Euro's) the Board is willing to take?
- What is the variability in pension outcomes that the Board accepts/pursues?
- What is the sensitivity of pension outcomes due to economic/ demographic risks in normal and stressed economies?

These types of questions coupled with ALM scenario analysis help the board to understand the risks that the fund faces and how the fund feels about these risks. The outcome of these sessions usually leads to the risk appetite statement where the fund addresses the short, medium and long-term horizons regarding their risk appetite. The risk appetite statement is usually expressed in qualitative terms and quantitative terms. The risk appetite is thus the funds tolerance for various risks that the fund faces when pursuing its investment objectives. In qualitative terms, this would translate into a document describing the tolerance levels for specific risks in different areas for the fund (investment risk, liquidity risk, valuation risk etc.). On the quantitative level, risk appetite would state the limits or maximum losses in case of several scenarios that could happen. More importantly, the risk appetite is crucial in the asset portfolio as the amount of risk the fund is willing to take directly translates to the portfolio. Funds that have bigger risk appetites are more willing to take on risk to earn a higher return which potentially can lead to the fund investing in asset categories that are considered riskier. Higher risk appetite could thus be associated with a higher equity level in the portfolio as equities are considered riskier than fixed income investments.

The importance of defining the risk appetite cannot be understated. Ortec finance states as a rule of thumb that 1% extra return is equal to 30% higher pensions or 30% lower premiums (Hoogdalem, Kramer, Finance, & Burgt, 2010) Risk appetite is certainly important when given the fact that on average every year the Global stock exchanges face a 2.5% chance of decreasing more than 30% (Hoogdalem et al., 2010).

## 2.5 Operationalizing Risk appetite in the pension fund setting

To operationalize risk appetite, I will make use of the theory of the life cycle model. In 1989, Samuelson argued that savings should be invested in an asset mix that represents the point in the life cycle in which the user is in. The life cycle theory suggests that a person’s risk appetite varies over the course of their life. When a person is young and in the early stages of their life cycle, their risk appetite is larger as they are better able to take a loss. For example, young people can anticipate on disappointing investment returns by extending their (yearly) working period, while older people have fewer opportunities to do so. The life cycle theory seems to suggest that people who approach retirement age have lower risk appetite and thus should invest less in risky assets like equity and more in riskless considered assets (Bikker, Broeders, Hollanders, & Ponds, 2012). The life cycle model contains an important implication for pension funds namely if we can equity allocation as a proxy for the risk appetite that the fund has chosen. By calculating equity percentages of the allocation, I can proxy for risk appetite in our research.

In this paper, the risk appetite of the fund of the fund will be defined by the equity allocation of the fund. As equity is the riskiest asset category of the fund, it will be a good proxy for risk appetite.

## 2.5 Factors determining the Risk appetite of Canadian pension funds

In this section, the theoretical background for the factors determining the risk appetite of Canadian pension funds will be laid. The risk appetite of Canadian pension funds can be influenced by several different factors which all have effect on the equity share of the pension funds. Potential factors that influence the risk appetite could be, the average age of participants in the pension fund, the size of the fund, the regulation that the pension fund endures or the industry to which the pension fund belongs too. In this section, academic literature will be presented that will elaborate on the specifics of factors that drive the risk appetite of Canadian pension funds. Subsequently, the hypotheses will be stated on whether the chosen factors really influence the risk appetite of pension funds.

### 2.5.1 Size of the Pension fund

In 2009, Bikkers and Dreu conducted a study on the effects of size on the operating costs for the pension fund. They found that pension funds larger in size tend to invest more in equity (Bikker et al., 2012). According to the researcher's pension funds, larger in size will also be run more professionally leading to better investment expertise and conversely leading to a higher equity share as they can better understand the risk return properties of equity (Bikker & Dreu, 2011).

Similarly, another study by Bikker, Broeders, Hollanders, and Ponds (2011), further investigated the link between the size of Dutch pension funds and their equity shares. Researchers took the number of participants in the plan as the size variable and regressed this on the equity share of the pension funds. They found that an increase in the total number of members in the plan from 10,000 to 100,000 led to an increase in the equity exposure of the fund by 2.5 percentage units (Bikker et al., 2012).This builds on the research of Bikkers from 2012 where he and Dreu already established this link between size and equity share.

Bikkers also make the case that pension funds have become too big to fail as they perform such an important duty in society. Thus, governments will never let them default as it will risk the pension of huge percentages of the population. This lender of last resort for pension funds was observed in Mexico during the crisis where before the crisis pension funds were taking excessive risk as they knew that the Mexican government would bail them out in case of emergency (Sidaoui, n.d.)
The literature of Bikker et al (2011) led me to forming the first hypothesis.

**Hypothesis 1: The Size of Canadian pension funds is positively related to the equity share of the pension fund.**

Bikker et al (2011) used the total number of participants in the pension fund to classify size. Since not all the pension funds in the dataset reporting their member count in this paper, the total sum of assets under holding will be used as the size variable. Bikker et al (2011) also notes that "Since size measured by total assets is highly correlated with size measures by total participants (.087) , the latter may be considered as a relevant and valid instrumental variable for the former" which indicates that using total assets instead of participants can be used in the analysis (Bikker et al., 2012)

### 2.5.2 Average age of the pension funds participants

The average age of pension funds participants can be of significant influence on the investment strategy and consequently the equity shares of the pension fund. The life cycle theory is the intuition behind this. The life cycle theory deposits that younger participants should be able to take more risk since they are far away from retirement and this risk can be diversified away during the period. When participants reach older age and near retirement age, they should want security of their pension and lower their share in equities and invest more in fixed income. When this theory is applied to pension funds, it becomes clear that a bigger share of older participants in the fund could lead to lower equity share in the fund.
In 2006, Alestalo and Puttonen conducted a study on the asset allocation of Finnish pension funds. Their research among other things studied whether "younger" pension funds invest riskier and thus higher equity shares than "older" pension funds. Their reasoning was that younger pension funds have longer investment horizons than older ones in accordance with therefore mentioned life cycle theory. The authors of the study found that increase in the

average age of participants by 1 year decreases the equity investment by the fund with 1.7 percentage point (Alestalo & Puttonen, 2006). The data set they used contained 42 pension funds from the year 2002. Further, the study noted that there is huge variation in equity levels between the funds as equity level were between 0-70 percent.

Another study that looks at the relationship between age and equity share is the earlier mentioned study of Bikker, Broeder, Hollanders and Ponds (2011). Bikker et al investigated the relationship by using the life cycle theory saving and investing model. The data of the Bikker et al paper contained the asset allocations of 569 Dutch pension funds for the year 2007. Bikker et al came to the same conclusion as the Alestalo and Puttonen namely that the equity share of the fund decreases as the fund gets as the average age in the fund increases. Bikker et al found that an increase in the average of 1 year decreases the investment by 0.5 percentage point of the fund (Bikker et al., 2012)

The study of Gerber and Weber (2007) looked at the Swiss pension fund sector, their study features Swiss pension funds in the period 2000-2002. The Study by Gerber and Weber is similar in nature to the Bikker and Alestalo studies as they regress several factors on the asset allocation of pension funds. Geber and Weber came to the same conclusions as the afore mentioned studies that there is a negative relationship between the average of the participants in the pension fund and the equity share of the fund. Gerber and Weber found that if the average age of the fund increases by 1 year, the fund decreases its equity share by 0.18 percentage point (Weber & Gerber, 2007).

The mentioned literature provides solid grounds to test whether the age of pension participants is of effect on the equity share of the Canadian pension funds. I form the following second hypothesis.

**Hypothesis 2: The Average age of the fund has a negative effect on the equity share**

One thing to note is that the studies mentioned above had very specific age of members of the pension funds. Our database does not contain the age of the pension fund participants. To overcome this, we will construct the Maturity variable where pension funds payments divided by the total liabilities proxy for the average Age of the pension fund.

### 2.5.3 Funding ratio of the fund

The funding ratio is of great significance to the pension fund. The funding ratio is an indicator of how healthy the fund is and its ability to pay out benefits in the future. The funding ratio is especially important with DB funds as the fund itself bears the investment risk. This could mean that funding ratio has relationship with the risk appetite of the pension fund. Pension funds with higher funding levels could potentially invest more in riskier asset categories such as equities which could potentially earn them higher returns. If the fund is healthy, it will enable the fund to invest more aggressively as a big part of their pension benefits are already secured by the high funding level. The study by Alestalo already previously considered this in their study. They found that fund with higher funding levels tend to invest a bit more aggressively and conversely have higher shares of equity in their portfolio (Alestalo & Puttonen, 2006).Another study by Joshua Rauh considered the same theory that high funding levels equate to higher shares of equity. Rauh found that well-funded pension plans allocate a larger share of their portfolio to equity while funds with lower funding levels tend to invest more in safe securities such as fixed income (Rauh, 2016). Finally, the study by Bikker et al previously mentioned found the same relation between higher funding levels and high equity shares (Bikker et al., 2012).
The aforementioned literature lead to the third hypothesis.’

**Hypothesis 3: High funding levels translate to higher equity shares in the portfolio**

# Chapter 3 The Canadian pension system

## 3.1 History

This section will give an overview of the history of the Canadian pension market and some of the major reforms that have affected it.

The first semblance of state provided care for the retired came in 1908 when the government decided to introduce government Annuities (Baker, 1997). This 'Canadian Government Annuities Act of 1908' was the first instance in which the government provided ways for the elderly to secure their income after they retired. The act enabled Canadians to purchase annuities with varying length and amounts so that the buyer would receive monthly fixed benefits appropriate for their situation. The annuities themselves were backed by the government ensuring the continuity of these products (Baker, 1997).

The industrialization coupled with the First World War left many elderlies in a state of poverty. The shifting economy favoured a young work force and older people were left by the wayside. Poverty among the elderly was common and the younger generation was struggling to provide for their own family and their parents (Baker, 1997). The government acted on this and in 1927 introduced the 'Old age pensions act'. The act provided British subjects over the age of 70 with a maximum pension of 240 Canadian $ per year. Eligibility for this scheme was quite limited as there were several other requirements to join which limited participation (Overview, 2007).

The great depression of the 1930's showed the Canadian government that a national system had to be set up, so that all elderly could be taken care of as many Canadians did not qualify for the 1927 old age pensions act. The participation of Canada in the Second World War in 1939 gave a much-needed boost to the faltering Canadian economy. In 1952, the 'Old age security' law was enacted. This provided pension for all seniors above the age of 70 and had lived in Canada for at least 20 years (Overview, 2007). The OAS was a monthly benefit program that was funded through the tax revenue of the Canadian government. Anybody who met the requirements was entitled to this monthly benefit payment.

Still, the OAS meant that Canadians who decided to retire experienced a steep income drop as the OAS pension had a maximum of 480$ per year. Thus, the OAS led to the introduction of employment based pension plans that would be transferrable from job to job. This led to the establishment of the Canada pension plan (CPP) and the Quebec pension plan (QPP) (Baker, 1997). The CPP and QPP together form the second pillar of the current Canadian pension system.

Furthermore, in 1967 the ‘Guaranteed income supplement’ (GIS) was introduced as a measure to further reduce the property among seniors in Canada. The GIS was a supplement that boosted the income of Canada’s lowest income seniors, and to help those who reached 65 years of age before the full Canada pension plans came available. (Baker, 1997).

### 3.2 Demographic situation in Canada

The current Canadian government is facing a problem that can be found across the modern developed world. Canada is aging, the seniors are becoming an ever increasing age group within Canadian society (Certified General Accountants of Canada, 2005). Canada is witnessing an ever-increasing large number of people growing old. This is a serious concern for the Canadian government as it has the potential to bankrupt pension plans and social cohesion. Next to this, it will only further increase the strain on the already compromised Canadian health care system (Statistics Canada, 2014). On July 2014, the total Canadian population was estimated at 35.54 million people, from this 35 million, approximately 15.7 % was aged 60 years or older (Statistics Canada, 2014). According to the globeAgewatch index, by 2050 nearly thirty percent of all Canadians will be 60 or older. The number of seniors in Canada is expected to increase from 4.2 million to 9.8 million between 2005 and 2036 which would equate to 24.5 % of the total population. The median age in 2011 for Canadians was 39.9 years in contrast to the median age in 1971 that was 26.2 years (Statistics Canada, 2014). Also, the fertility rate of Canadians is at an all-time low with 1.49 children being born per woman, much less than the needed replacement rate of 2.1 children per woman. The aging issue is not new for the Canadian government. In 2003, the government published a rapport named Population Aging: from problem to opportunity. The rapport outlined how the Canadian government could potentially profit from the aging population. The rapport did outline Canada still faces significant risks if the rate with which Canada is aging is not slowed down (Discussion, For, Flexibility, Data, & Thinking, n.d.) As of 2011, according to OECD data, Canada spends around 4.3 percent of its GDP on total pension spending.

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## 3.3 Comparison of the Canadian pension market to other Countries

The Canadian pension system is currently one of the healthiest in the world, it scores well on multiple pension rankings that look at sustainability, fairness and adequacy. The only countries that rank above it are the Netherlands and Denmark (Mercer, 2015). I will make a small comparison in this section to compare Canada to other OECD countries.

The total asset size of the Canadian pension market is 1526 billion USD, which makes it the fifth largest pension market in terms of total asset size. Other big markets include the USA, UK and japan which together make up for around 90% of the total pension asset market (Watson, 2015). Total assets as percentage of GDP for the Canadian sector is 85.1%. In comparison, we see other OECD countries such as the Netherlands and Switzerland having percentages of 165.5 and 121.2 respectively. The Canadian market is still a mainly DB market with approximately 96% of pension funds offering DB schemes (Watson, 2015).

| | Total assets (USD billion) 2014 | % GDP in USD billion | | Total assets (USD billion) 2014 | % GDP in USD billion |
|---|---|---|---|---|---|
| Australia | 1675 | 113% | Mexico | 190 | 15% |
| Brazil | 268 | 12% | Netherlands | 1457 | 166% |
| Canada | 1526 | 85% | South Africa | 234 | 69% |
| France | 171 | 6% | South Korea | 511 | 35% |
| Germany | 520 | 14% | Switzerland | 823 | 121% |
| Hong Kong | 120 | 41% | UK | 3309 | 116% |
| Ireland | 132 | 54% | US | 22117 | 127% |
| Japan | 2862 | 60% | Malaysia | 205 | 61% |

**Table 1 (Watson, 2015).**

### 3.4 Median Replacement rates at retirement

One of the goals of retirement is that retirees should not experience a significant drop in their welfare/standard of living when they decide to retire. Replacement rates capture this by indicating what level of earnings will be replaced by future pension payments (MacDonald & Moore, 2011).

This rate has significant value as it indicates the post retirement standard of living and could signal a big drop in standard of living (Larochelle-Côté, Picot, & Myles, 2010). One rule of thumb that Canada welfare suggests is that future pensioners should strive for a replacement rate of 70%. This 70% percent is also quoted by a lot of web based financial planning products (Scholz & Seshadri, 2009). There is some debate on whether this 70 to 80% is a useful benchmark for judging replacement rates, notably Bonnie-Jeanne MacDonald challenges this percentage as she proposed that an alternative measure as a basis for assessing how well people maintain their living standards after retirement: the living standards replacement rate (MacDonald & Moore, 2011).

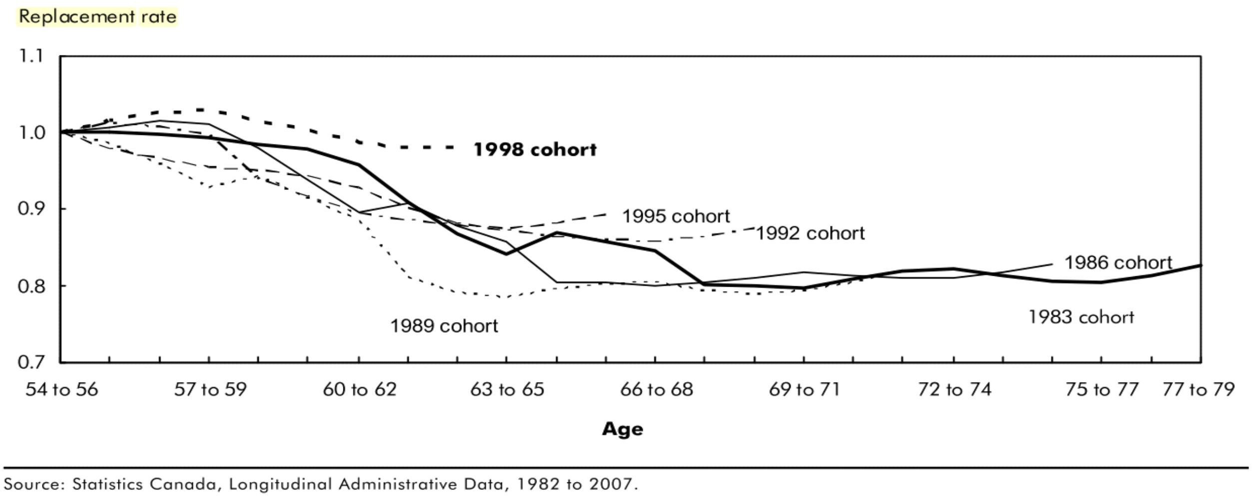


**Figure 2**

Figure 2 above shows the median replacement rates of family adult-equivalent adjusted income for all individuals by cohort. It shows the replacement rates for five age cohorts. From the graph, it can be seen that more recent cohorts seem to have better replacement rates than the first cohort of 1983. More recent cohorts thus have higher replacement rates and less of a drop-in living standard. The median rate of 80% would indicate that the Canadian pension system is effective at maintaining the standard of living (Larochelle-Côté et al., 2010).

### 3.5 Overview of the current Canadian pension system

According to the 2015, ‘pensions at a glance’ report from the OECD, Canada has a pension system that consists of three pillars (OECD, 2013). In the following section, the Canadian Pension system will thus be described by the OECD classification of three pillars:

The first pillar consists of programs that are financed from the general tax revenues that the government collects. The first pillar is available to the elderly in society based on their age plus years of residence and or citizenship. The second pillar consist of compulsory programs that are in designed to replace pre-retirement earnings. The programs in the second pillar can either be defined benefit (DB) or can be defined contribution (DC) The third and final pillar consist of privately administered retirement income plans. These plans can either be provided by their employers (RPP’s) or can be individual tax assisted retirement saving accounts.

The first two pillars of the Canadian pension system consist of pension savings that are mandatory as they are taxed out of the general income (Baldwin, 2009). The third pillar in Canada consists of a defined contribution or defined benefit voluntary savings plan that has contributions from the employer and the individual.

Pension plans can be funded in a pay as you go manner or in a fully pre-funded manner. In the pay as you go setting, contributions from the current period pay for the benefit payments in the current period(Certified General Accountants of Canada, 2005).There is no pension reserve and there are also no investments and investment related decisions (Certified General Accountants of Canada, 2005).

In the fully prefunded setting contributions, in a particular year match the present value of future benefit payments. Assets that accumulate in the fund match the amount of financial obligation that the fund has. If there is underfunding and the assets are not enough to cover the financial obligation, additional payments are needed to match the assets to the accruing benefits (Barr & Diamond, 2006).

First Pillar programs are almost exclusively pay as you go funded, Second pillar programs tend to be a bit more varied with a mix of Pay as you go and fully funded systems (OECD, 2007) .The difference tends to be in the way on which tax base the programs are levied. The first pillar programs are usually funded through the general revenue tax of the government (Baldwin, 2009). The second pillar is usually funded through taxes that are levied though labour income taxes. Figure 2, on the next page visualizes the Canadian pension system.

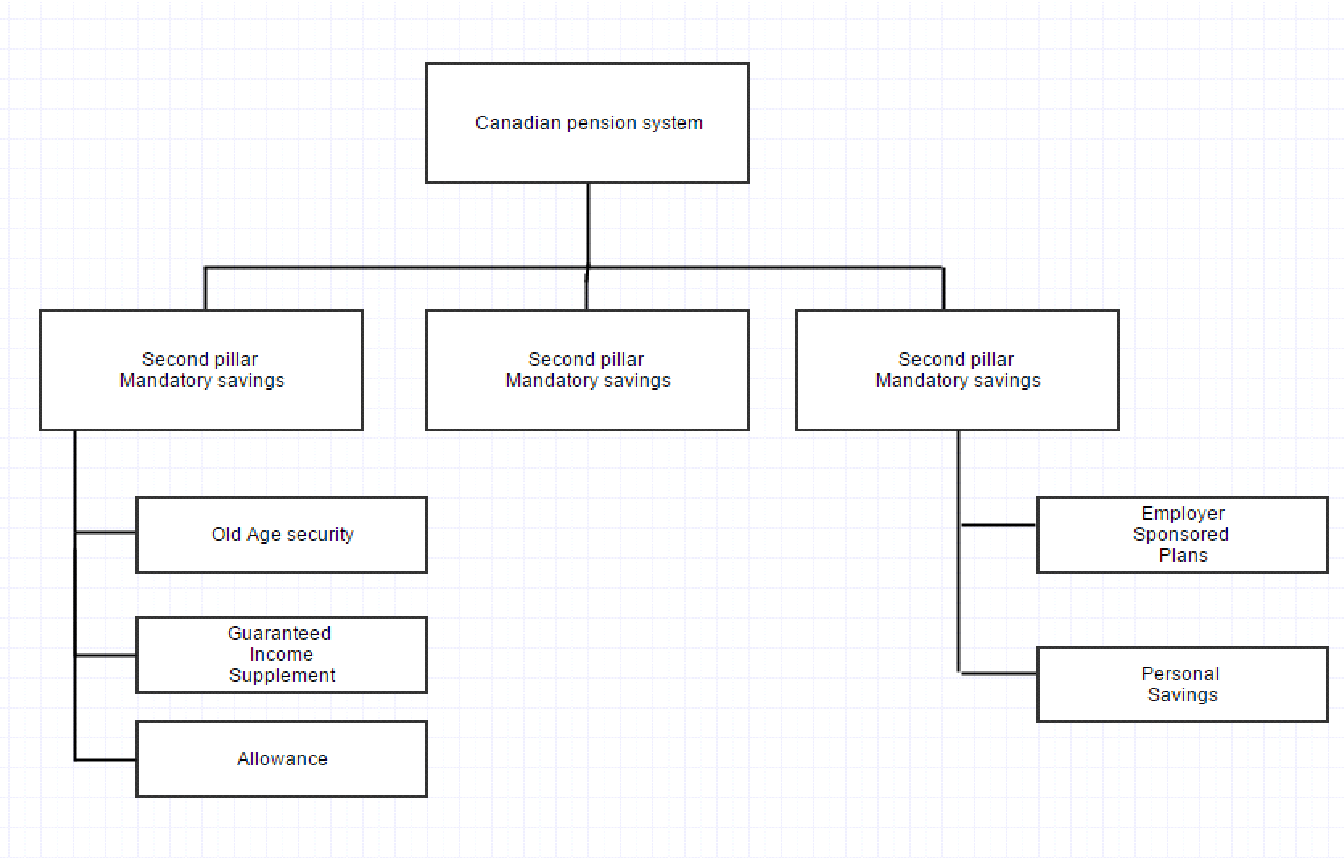


**Figure 3**

## 3.6 The first pillar (OAS), GIS, Allowance

### OAS

The first pillar in the Canadian pension system consists of the old age security (OAS), the Guaranteed income supplement (GIS), and the mentioned allowance. The OAS is a program that goes back to the year 1952 when it was first implemented (Baker, 1997). The OAS is a monthly payment that is funded through the revenues of the Canadian government. The OAS can thus be defined as a pay as you go system as the retirees do not pay directly for the OAS. The OAS is funded by the working generation of Canada who pay for the current retirees, it can be compared to the AOW in the Dutch pension system. The OAS is available for all Canadian subjects if they meet the legal and residence requirements (Baldwin, 2009). If the subject has lived in Canada for 40 years, then they are entitled to the full OAS payment. The legal age to receive the OAS is 65 years.

**GIS**

Next to the AOS, there is the guaranteed income supplement. This supplement provides an extra monthly benefit next to the AOS meant to support pensioners in Canada who fall under a certain income threshold. There is an income requirement to be eligible for the GIS, every year the subject is evaluated whether they still apply for the income supplement, if their income exceeds the benchmark they are not entitled to the supplement (Baldwin, 2009).

**Allowance**

The final part of the first pillar consists of the allowance. The allowance applies for Canadians aged between 60 and 64 whose partner is already receiving OAS and GIS. The allowance also applies for those whose partner has passed away or did not remarry. For this category, the survivor allowance applies.

The first pillar can be defined as a pay as you go system where the current working generation transfers their income to the current pensioners they are in a sense direct subsidies to seniors (OECD, 2007). The first pillar is basic income for old people and their safety net, as anybody who meets the requirements has a right to it without directly having paid for it. As of 2015, the OAS has constantly been indexed to the CPI keeping up with the price inflation (Benefits, n.d.). The first pillar be a safety net for those who could not save enough income during their working life.

## 3.7 The Second pillar

The second pillar in Canada is a public mandatory earnings scheme. The second pillar in Canada consists of the Canada pension plan (CPP) and the Quebec pension plan (QPP). It is a universal plan meaning that all Canadians are covered and forced to participate (Benefits, n.d.). The CPP and QPP are not funded through the revenues of the government, but instead by direct contribution of their participants. Participants save up over the course of their working life and their pension income is linked to the amount accumulated in their accounts. The CPP and QPP reinvest the contributions and reimburse when the participants reach the pension age. Participation into the CPP or QPP is mandatory as dictated by Canadian law, opting out is not an option (Baldwin, 2009).

The CPP and QPP are very similar in how they operate, the difference being that the CPP serves the English-speaking part of Canada and the QPP the French speaking part. The CPP and QPP work together ensuring that all citizens of Canada are covered.

The CPP and QPP provide benefits for the following four categories namely Retirement pension, Disability Benefits, Survivor benefits and Children's benefits for students until 25.

## 3.8 The Third pillar personal savings and employer sponsored plans (RPP's & setup)

The third pillar in the Canadian pension system consists of the Employer sponsored plan and the personal savings of retirees.

**Personal savings**

The first part of the third pillar is the personal savings, these come mainly in the form of "registered retirement savings plan" or also called RRSP (Baldwin, 2009). RRSP's are personal savings plans for retirement where participants set up and register their own pension plan. Participants deposit every year a small portion of their salary into their personal plan. The RRSP contributions are tax deductible as a way of incentivizing extra individual pension savings. There is a limit RRSP contribution limit of 22450$ Canadian dollar (Benefits, n.d.).

**Employer sponsored saving plan (RPP's)**

The benefit plans provided by employers are old age income plans which can be DC and DB in nature. These retirement savings plan typically consist of the pooled funds of employees with matching contributions by the employer (OECD, 2007). These plans are also commonly referred to as 'Registered Pension Plans' (RPP's). The pooled money is invested and returned to the plan members at retirement age.  The employer is typically the one making the investment decisions, or delegates the investment decisions to an external party. Governments typically incentivize the creation of these savings plans as they allow for tax breaks for the company making them financially attractive. The plan members cannot withdraw their money at their own wish, they must wait until retirement age is reached to receive the benefit payments (Benefits, n.d.). Canada does not impose any investment regulation on these funds. According to the OECD, Canada is one of eleven that place no limits on investment except that the equity stake in one company cannot be larger than 30% ("Annual Survey of Investment Regulation," 2013).

### 3.8.1 Set up of RPP's

As mentioned before the RPP's broadly come in two different types namely the defined contribution (DC) and defined benefit (DB) set up. In Canada, these two categories are distinguished by the '*Pension Benefits Standards Act, 1985* '(Discussion et al., n.d.).

**Defined Contribution**

The defined contribution is conceptually simpler than the defined benefit set up. In a defined contribution set up, participants have personal accounts in which the employer makes and the employee both make regularly contributions (OECD, 2007). The contributions are usually based on predefined percentage of salary. The contributions to these funds are tax deductible making them a deferred savings account, also the investment income comes tax free. In some cases, the employee has some control over what type of assets the external manager should invest in or in what funds to invest or which strategy to follow. The future benefit payments a participant will receive is based on the total contribution in the account and the total investment earnings over the contributions. When the participant retires, he will receive an annuity or can in some cases choose for the lump sum payment (Benefits, n.d.). The important take away is that there is no guarantee of any benefit, the future benefit is solely reliant on the amount contributed and return generated on this amount. As mentioned before, the total number of funds in the account is invested mostly by an external partner. These plans often have yearly updates in which the participant can see what the total accumulated amount is and the corresponding future potential benefits (Baldwin, 2009). Employers tend to prefer the DC set up as they do not bear the risk of the investment, only the participant faces risk. Since the future benefit payments are not known beforehand, they depend solely on the amount invested and return these plans cannot be underfunded, they are thus considered fully funded as there is no liability (Bodie, Marcus, & Merton, 1988).

**Defined benefit**

In a defined benefit set up, the potential future benefits of the employee are determined by a formula which takes into account the years of service for the employer and also the wages earned by the employee during the working period (Franzen, 2010). Often the formula also incorporates the social security benefits the employee might have received during the period of employment. Some of the significant differences between DC and DB pension funds is that in the DC set up the employee bears all the risk of the investments. In the DB set up, the employer promises a certain future benefit meaning that the employer bears the risk (Brown & Liu, 2001). In the DB setup, the pension fund can thus be underfunded when the promised future benefit (liability) reaches a higher level than the current level of assets. Underfunding spells trouble for funds as it means that they do not have enough funds to fund their future benefit payments and potentially need to cut back on future benefits or indexing of current pensions.

## 3.9 Facts about Canadian pensions

### *3.9.1 First and Second pillar coverage*

In 2011, the Canadian government conducted a study on the composition of Canadian retirement income. As expected, around 95% percent of all Canadian seniors receive income from the basic old age security pension, the GIS supplement or the supplement that covers persons and survivors of retirees between the ages 60-64.

Also, around 92% of all Canadian seniors receive income from the second pillar (CPP/QPP). This amounted to 4.4 million pensioners receiving CPP/QPP benefits and around 4.6 million seniors receiving OAS benefits in 2011 (ESDC).

### *3.9.2Pension (RPP) Coverage and Pension savings*

All Canadians are covered by the pay as you go first pillar (OAS) and the mandatory second pillar (CPP, QPP). The third pillar which houses the RPP’s are of interest, these RPP’s are a key component of Canadians retirement income. Over the past 30 years, the percentage of male Canadians with RPP’s at their workplace has fell significantly from 52% in 1977 to 37 % in 2011, while the woman’s participation in RPP’s has gone up over the same period from 37% to 40%. The decline in men participation is due to decline in DB RPP plans and increase in the number of DC/hybrid schemes. The overall increase in women’s RPP coverage was the result of a steady gain in defined contribution or hybrid/mixed RPP coverage counterbalancing the slight decline in their DB coverage. It must be noted that RRSP savings have increased dramatically over the past 30 years and could explain the fall in RPP coverage. Also offering RPP coverage is costly for firms. Administration costs coupled with the associated problems with underfunding make a lot of companies reconsider their RPP offering.

### *3.9.3 Average amount of income*

In 2011, the median amount of income received from the OAS/GIS was around 6400$ per year. The median income received through the CPP/QPP in 2011 was 7000 $, the median income from the RPP's and RRSP's was around 11800 $. Lastly, the income median income for investments was 1200 $ and employment median income was 2600 $.

### *3.9.4 Percentual income*

When all public pensions are combined (OAS, GIS, CPP/QPP), they make up around 41.2 percent of the total income received by seniors in Canada. Approximately one third (33.7%) of the total income comes from the third pillar (RPPP's, RRSP's). The remaining income comes from investment income and other income sources.

### 3.10 Regulation of RPP's

In Canada, the jurisdiction regarding pension funds is split between the federal level and the Provincial level. The federal government controls the tax deferral/shelter and limits the tax deductibility and the provincial level sets minimum standards for design, funding and communication. Administration, Banks and communications companies etc. are exempted from the federal and provincial rules as they are included in the 1985 Federal Pension Benefits Standards Act (Riesen, 2009)

Legislation regarding tax has changed significantly over time, but all pension plans (except for banks etc.) fall under the same federal rules regarding tax. The same cannot be said for provincial level legislation. Provinces in Canada have their own pension legislation that can significantly differ from province to province. Even national employers with employees in every province must abide by every provincial law. Canada is unique in this regard that the Constitution of Canada gives authority over pension standards to provinces. To make matters even more complicated different aspects of pension policy are governed by different ministries. At present, the finance, labour, justice all govern different parts of pension legislation (Spencer & Soden, 2003).

Provincial Legislation regarding pensions stretches over a very broad period (1965-1993). As of current, there is one province that hasn't enacted provincial legislation around pensions and that is Prince Edward Island. The first province to establish pension regulation was the Province of Ontario in the year of 1965. Several other provinces established their own regulation at the end of the 60's. The few remaining provinces (Atlantic Provinces and British Columbia) established their regulation at the end of the 1980's. In 1987, a big reform wave swept across the provinces after the government pressured the provinces. These reforms included better access to benefits and better security of potential benefits. Also, the period the participant should have had employment to receive benefit was reduced (Riesen, 2009). What remained were significant differences between the provinces as each province went about the reforms in their own way.

The heterogeneity of provincial legislation remained a thorn in the eye of the federal government. To combat the wild spread of legislation, in 1970 the government proposed to extend the second pillar (CPP, QPP). This proposal would have meant that the third pillar with private pension plans would have been redundant and thereby addressing the issue of differing provincial legislation. However, the proposal never materialized and the system remained as is (Pugh, 2006)

Another attempt at addressing the issue was made in 1974, by introducing the Canadian Association of Pension Supervisory Authorities (CAPSA). The CAPSA tries to harmonize pension regulation on a federal and provincial level. The CAPSA has close relations with the Canadian institute of Actuaries (CIA), which benefits the pension regulation as it seen to be quite consistent in the whole country (Pugh, 2006).

The final attempt to harmonize pension legislation came in 1987 when the Treasurer of Ontario (Larry Grossman) led a push for a multi provincial accord to harmonize provincial legislation. While some progress made, still the heterogeneity remained. (Riesen, 2009)

After 1987, pension legislation diverged even more into the hotpot of legislation that is now. Provincial legislation differs significantly and no significant attempt has been made to address this.

## 3.11 Funding/solvency legislation for RPP's

As mentioned before, defined benefit plans in Canada fall under provincial and federal legislation depending on where the plan is located. But regarding funding legislation, all the DB pension fund plans in Canada must perform an actuarial valuation every three year. This must be done in accordance with one of the provincial or federal regulators.

The actuarial valuation must consist of a going concern valuation and solvency valuation. The going concern valuation bases itself on the long run values of assets and liabilities of the fund. The going concern valuation looks at the short term whether the liabilities exceed the assets.

If the pension fund is found to be in deficit in the going concern valuation (thus liabilities exceeding assets) having a funded ratio of below 100% the deficit must be funded by the plan sponsor over a maximum of 15 years. This usually means that the sponsor must make extra contributions to close the shortfall next to the regular contributions.

The solvency test is performed under the assumption that the Plan is to terminate on the valuation day. Usually the plans assets are valuated using market values of fair values (Walsh, n.d.). The main assumption when evaluating the liabilities is the valuation rate of interest. In the Canadian actuarial valuation, the rate is set for the first 15 years from the valuation date to be equal to the yield on government of Canada long term bonds plus a spread of 0.5% (Walsh, n.d.). For periods after the first 15 years a 6% rate is used (Walsh, n.d.). A solvency deficit must be dealt with within 5 years.

If the plan is state of deficit in the going concern valuation and solvency valuation then the higher required minimum payment is binding (Armstrong, 2006).

### 3.12 Asset allocation legislation of RPP's

Pension funds are subjected to various legislation concerning their investment decisions and asset allocation. Investment regulation in OECD countries comes in two forms, namely the quantitative asset restrictions (QAR) and the prudent person rule (PPR). The quantitative asset restrictions are strict government enforced limits on investment. Typically, QAR's limit the investment in certain asset percentile caps or hard caps (Davis & Hu, 2008) .The second form of investment regulation is the Prudent Person rule. Davis (2002) aptly defines the PPR by "a prudent person rule stipulates that investments should be made in such a way that they are considered to be handled 'prudently' (as someone would do in the conduct of his or her own affairs)" (Davis, 2002). In the context of pension investment, this would mean that the investment manager should invest as he would do with his own assets.

QAR's can be found mainly in emerging markets but also in OECD members such as Sweden, Denmark and Spain (OECD SURVEY). The PPR rule is implemented in countries such as Australia, Canada, Ireland, Italy, Japan, the Netherlands, the UK and the US (OECD, 2007).

This does not mean that Canada is without any regulation. Until 2005, pension funds in Canada were not allowed to invest more than 30% of their portfolio in foreign equity ("Annual Survey of Investment Regulation," 2013). Next to this, Canadian pension funds were not allowed to invest more than 25% of their portfolio in real estate and not more than 15% in Canadian resource properties (timber, mines) until 2010. Canada is one of nine countries that does not have any rules regarding the ceiling to pension fund investments ("Annual Survey of Investment Regulation," 2013). There are some rules regarding other investments as Canadian pension funds are not allowed to invest in foreign currency exposure and there is a limit on the number of derivatives. Canadian pension funds are also not allowed to have ownership of more than 30% in one company. Finally, no more than 10% of total book value of assets may be invested in securities, stocks, bonds and notes of one company or person (OECD, 2007). Figure 3 on the next page outlines some of the regulation regarding asset management in Canada.

| Country | Prudent person rule/diversification rules | Quantitative restrictions on domestic assets | Self-investment and ownership concentration |
|---|---|---|---|
| Canada | PPR, Maximum of 10 % of pension fund assets in liabilities of one company, Maximum 5% of assets in a single item of real estate or single resource property | Real estate and resource limit to 25 and 15% for resource properties. Securities must be acquired on public exchange | Related party investment not permitted; maximum 30% of voting shares of one company. |

**Figure 4**

## 3.13 Pension fund investment

Before investigating what factors drive risk appetite of pension funds, it is important to research how pension funds invest optimally. In the Canadian pension sector, there has been a trend from DB to switch to DC set ups, although experts (Brown & Liu, 2001) indicate that this has been happening at a slower rate than other OECD countries. The funds looked at, in this thesis, are all DB funds, DB funds have different considerations when investing than DC funds. The difference being as explained earlier that DB funds bear the investment risk and DC plans do not (Statistics Canada, 2014).

In the DB setting, the pension plan knows what benefit it should deliver to the recipient since it is based on the last salary of the pensioner. Regardless of the performance, the pension fund will have to deliver the promised benefit putting the investment risk with the pension fund. In the DC setting, there is no guarantee of a specific benefit, the risk is lies with the participant. If the investments turn out less than satisfactory, then that is their own problem. In the DC setting, there are no real liabilities to speak of only assets. Due to their differences, DB funds deal with different risks than DC funds do.

DB funds can become complicated instances in where the risk is shared between the fund and participant. In a normal setting, pension funds would use the efficient frontier analysis proposed by Markowitz Mean variance model. The model would then improve the investments of the pension funds. The problem with this type of analysis is that the Markowitz model does not incorporate the liabilities of the pension fund and only looks at the assets and the short term horizon (Campbell & Viceira, 2006). Countries where pension funds have followed this approach are the United States and the United Kingdom. Pension funds in these countries set particular target returns, based on the target returns the pension fund chooses its asset allocation.

The higher the % of risky assets in the strategic investment mix, the greater the reported future returns will be (Boender et al., 2009).This has led to asset mixes consisting of 70-80% that can be found in the aforementioned countries. These type of asset allocations subsequently led to devastating results during the crisis of 2008. Pension funds closed and participants of these funds where the ones suffering the consequences (Boender et al., 2009).

Since DB pension funds also need to consider their liabilities, an investment approach that considers liabilities would be most useful. One way that is in current use by DB funds is the ALM method short for Asset liability management. In general terms, ALM could be seen as a risk management method that tries to match the assets to their corresponding liabilities (Kleynen, n.d.).

## 3.14 The different Asset classes

### Equity

Equity commonly refers to stocks in the portfolio of a pension fund. Stocks are expected to achieve higher returns than bonds/fixed income. Equity, thus is a tool at the disposal of pension funds to meet their pension obligations in the future. According to the Equity risk premium theory, equity tends to outperform fixed income over long time periods. This higher return comes at a price as the volatility of equity is much higher than fixed income

### Fixed income

The second class are the fixed income instruments. Fixed income can be defined as a type of investing for which real return rates or periodic income is received at regular intervals at predictable levels. Fixed income can be bonds, swaps, foreign exchange and money markets. Fixed income investing is seen by some as the best way to provide for pension liabilities in the future. In general, fixed income tends to earn a lower return than equity but is much less risky.

### Real estate

A study by Hudson-Wilson et al (2005) explains why investors should consider incorporating real estate into their asset portfolios. Pension funds do this as real estate can be hedge against inflation as the future benefit payments of pension funds are distributed in real terms. The study of Hudson et al suggested that this was the main reason for Real estate inclusion into portfolios (Hudson-Wilson, Gordon, Fabozzi, Anson, & Giliberto, 2005)

### Other

The other category consists of several asset classes. These include hedge funds, private equity, and natural resources. The other category thus consists of a wide variety of asset classes that in general have very small asset allocations leading to lumping them together in the other category.

## 3.15 Example of asset mix for pension fund (OTTP)

In this chapter, I will outline how the Ontario teachers' pension plan arrives at their fund specific fund asset mix.

The Ontario teacher´s pension plan is Canada´s largest profession pension plan. The OTTP has 175.6 billion Canadian dollars in assets under its management. The fund includes 318,000 participants which all are teachers.

The construction of the asset mix starts with the investment beliefs of the fund. In the investment beliefs, the fund outlines its philosophy for earnings superior returns and managing related risks to ensure the long-term sustainability of the pension plan. Once the investment beliefs are set the OTTP takes into consideration the following factors in their asset mix construction.

**1)** the Board's desire to maintain stable contribution rates and benefit levels for the members and the Province;

**2)** demographics of Plan membership and the expected pattern for employment of teachers in Ontario;

**3)** the correlations between the Plan's assets and liabilities;

**4)** the Board's goal of achieving, at a minimum, a rate of return that supports the long-term sustainability of the Plan;

**5)** the characteristics of its categories of investments; and

**6)** adequate liquidity needed to fund current cash flow needs.

(OTTP, 2017)

Taking all this into consideration the OTTP arrives at the following boundaries for their asset mix seen in table 1. The table shows that fund establishes minimum, mid and maximum limits for every asset category possible.

| Exposure | Minimum | Mid point | Maximum |
|---|---|---|---|
| Equities | 32% | 37% | 42% |
| Fixed income | 20% | 33% | 45% |
| Inflation sensitive | 8% | 13% | 18% |
| Real assets | 21% | 26% | 31% |
| Credit | 2% | 7% | 12% |
| Absolute return strategies | 1% | 6% | 11% |

**Table 2** (OTTP, 2017)

### 3.16 Trends in Canadian DB Pension fund sector

One of the main trends in the current DB sector is the de risking of pension plans. The financial crisis of 2008, 2007 had an everlasting impression on pension boards across Canada. De risking broadly means that Canadian DB pension funds are looking for ways to make their Pension plans less risky and subsequently less volatile. This has led to varying trends in the Canadian pension sector. According to an article by the Canadian Pension and Benefits monitor, de risking has led to three definable trends namely, investing in alternative asset classes, less equity and increased share of annuities.

Investing in alternative asset classes is a trend that has been going on for quite some time now. In a 2005, Tuer and Woodman surveyed pension people about what trends were happening in the Canadian DB pension sector. They found that pension funds were already increasingly investing in alternative assets, e.g. property, hedge funds and commodities (Broadbent, Palumbo, & Woodman, 2006). This is due to mentioned de-risking but also the increased pressure to beat the market coupled with the low interest rate environment.

A smaller equity share in the asset allocation of Canadian DB pension funds is the second trend noted. Canadian pension funds are realizing that equity does not always matches up properly with their liabilities. This has led to increasing amount of DB funds lowering their equity shares and moving into assets that match better with the liabilities of the Pension fund.

Lastly, Canadian DB pension funds seem to be investing more and more into annuities. Historically speaking, the total Canadian annuity market is estimated to be around 1 billion a year. As of 2015, the Canadian annuity market has spiked upwards to 2.5 billion signalling that pension funds are shifting more and more funds into this market. This is due to pension funds recognizing that annuities can fit in their portfolio as an in management tool to assist in the aforementioned de risking and lead to less volatility for the pension fund (Broadbent et al., 2006).

# Chapter 4 Data & Methodology

## 4.1 Research Question

There is an increasing amount of pressure on the Canadian DB pension sector. For the year 2015, (87.6%) solvency rates have declined in comparison to the year 2014 (90%) (Aon, 2016) The increasing pressure is due to falling interest rates, lower market returns and currency devaluation for the Canadian Dollar. Also, the Financial Overseer of Ontario reported that the average solvency rate for the Ontario region was 78% as of the first quarter of 2016, and only 4% of the plans had a solvency ratio above acceptable levels (Ontario, 2016). This does not spell well for the future health of the DB as the Demographic situation for Canada is set to deteriorate into the future.

This raises an important question regarding Canadian pension funds: what is the investment strategy of Canadian pension funds? The turbulent global asset markets could lead to a dangerous scenario for the Canadian pension funds. Canadian pension funds invest in multiple asset categories ranging from equity, bonds, and property alternative investments. Equity is the riskiest category and largely also the biggest category among the asset portfolio's. Therefor the Equity share of the pension funds will define the risk appetite. Different factors determine the risk appetite such as demographic variables and other pension characteristics. Thus, the factors influencing the risk appetite of Canadian pension funds are of great interest leading to the following research question:

**What influences the Risk appetite (equity share) of Canadian pension funds?**

## 4.2 Data

Since this thesis focuses on the third pillar in the Canadian pension system, first a list of potential funds had to be constructed. Benefits Canada is an independent news website reporting mainly on developments in the Canadian pension sector. Every year, Benefits Canada reports the 100 biggest pension funds in Canada. This list formed the basis point for the analysis in the study. From that point, it meant that the data collection had to be done manually. There is a central database by the financial superintendent of Canada to which I unfortunately could not get access too. The alternative meant that all the funds in the dataset annual reports/financial statements were gathered. Then from these documents various info was extracted and entered into the data file.

We started with 100 funds, but as we went down the list, some funds would not provide any info or reports on their website. Funds that did not provide any information were emailed requesting financial statement info on the fund. Despite the multitude of emails sent out, some funds did not reply or did not want to hand out the info to non-members of the fund.

The final data set contains manually gathered information on 70 pension funds for the period 2010 to 2014. In the data set info on the assets, liabilities, pension payments and asset allocations can be found for all the funds over the afore mentioned period. Next to this, the data set also has information on the sector in which the pension fund is active e.g. public or private.

## 4.3 Descriptive statistics of the Dataset

In this part of the thesis, some descriptive statistics on the gathered data will be presented to give an initial impression of the data set.

### 4.3.1 First impression

Figure 5 presents the asset allocation in percentages of the 70 pension funds over the period 2010-2014. The figure consists of the four following asset categories Equity, fixed income, real estate and other. The variable other consists of differing type of investments ranging from hedge funds, private equity to naturel resources and commodities. These are lumped together in the variable as in many cases these investments small in comparison to the other asset classes.

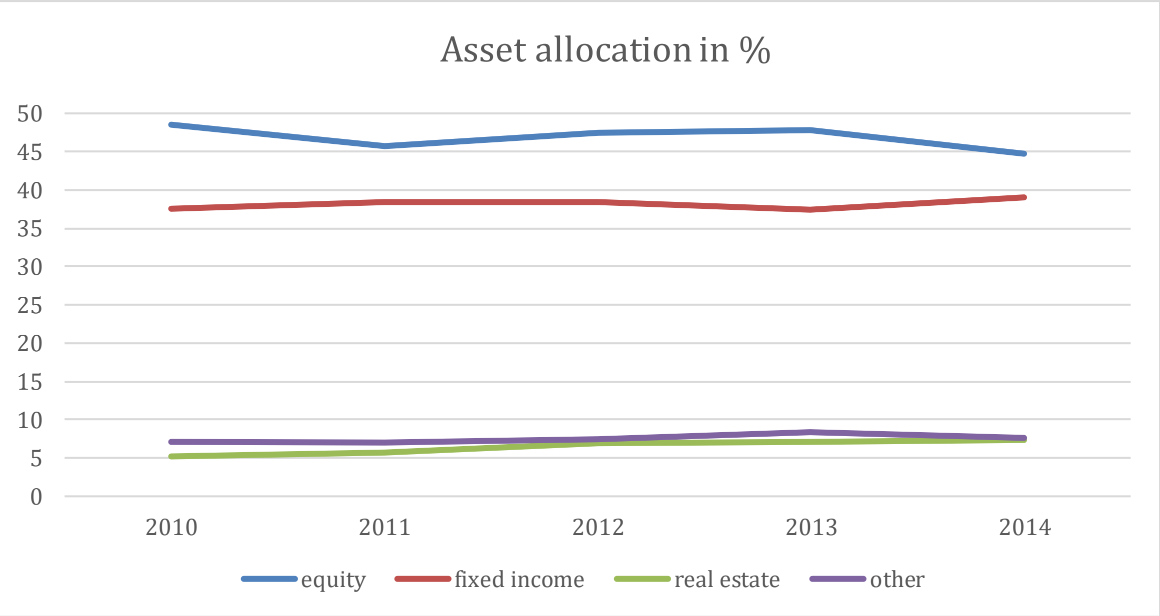


**Figure 5**

What is interesting to see is that over the period, there does not seem to be any significant fluctuation in asset portfolio allocation. Canadian pension funds seem to allocate their capital mainly into Equity and fixed income.  Over the period 2010-2014, pension funds invested on average 46.85 % of their total assets in equity based investments. Fixed income presented over the period 38.19% of the pension funds' assets. Real estate over the period accounted for 6.45 % of the fund's asset portfolio. Finally, the other variable constituted 8.85 % over the period.

4.3.2 Statistics of Independent variables

Table 3 presents the statistics of the equity allocation variable that we have constructed. What we can gather from the table is that slowly over the 2010-2014 period, Canadian funds on average have slowly been decreasing their equity holdings from 48, 5 % to 44, and 7 % in 2014. What is also interesting is the range in which the funds will allocate to their equity holdings. For example, in the year 2013, the maximum allocation is 73% while the lowest allocation is 0%. This is indicative of the difference in investing strategy that can be employed by the funds, i.e. High-risk equity allocations vs low risk fixed income allocations.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* |
|---|---|---|---|---|---|---|---|---|---|
| **Equity %** | 2010 | 58 | 48.528 | 13.638 | 49.600 | 0.000 | 67.000 | -1.811 | 7.123 |
| | 2011 | 59 | 45.729 | 14.765 | 47.900 | 0.000 | 71.400 | -1.460 | 5.791 |
| | 2012 | 59 | 47.423 | 12.382 | 49.181 | 0.000 | 68.000 | -1.168 | 5.559 |
| | 2013 | 58 | 47.831 | 13.924 | 50.350 | 0.000 | 73.000 | -0.916 | 4.221 |
| | 2014 | 57 | 44.737 | 14.877 | 49.000 | 0.000 | 67.900 | -1.084 | 4.156 |

**Table 3**

Table 4 shows the detailed statistics of the fixed income variable that we will be using. The same can be said for the fixed income allocation as for the equity allocation that the average allocation over the years seems to have changed significantly going form 37,6% in 2010 to 39,0 % in 2014 on average. We also observed that some funds in our dataset have allocated 100% of their allocation to fixed income while others have 0% fixed income allocation.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* |
|---|---|---|---|---|---|---|---|---|---|
| **Fixed income %** | 2010 | 58 | 37.606 | 15.672 | 34.400 | 0.000 | 100.000 | 1.233 | 7.461 |
| | 2011 | 59 | 38.460 | 16.621 | 36.226 | 0.000 | 100.000 | 0.710 | 5.997 |
| | 2012 | 59 | 38.423 | 16.462 | 35.000 | 0.000 | 100.000 | 1.093 | 5.608 |
| | 2013 | 58 | 37.429 | 17.407 | 32.100 | 0.000 | 100.000 | 1.041 | 4.704 |
| | 2014 | 57 | 39.035 | 18.234 | 35.500 | 0.000 | 100.000 | 0.761 | 4.255 |

**Table 4**

The following table 5 shows the statistics for our real estate allocation by the Canadian pension funds in our dataset. From the graph, we can observe that the real estate allocation is quite low on average for the funds. In 2010, we can see that the average real estate allocation is 5,212 which goes up quite significantly to 7.4 % in 2014, indicating that Funds have shifted more allocation to real estate investment. Here, we also observe differing allocations as in that the maximum allocation to real estate is 25, 3 in 2014 and the minimum being 0 %.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* |
|---|---|---|---|---|---|---|---|---|---|
| **Real estate %** | 2010 | 57 | 5.212 | 5.348 | 4.360 | 0.000 | 15.600 | 0.464 | 1.725 |
| | 2011 | 58 | 5.755 | 5.917 | 3.850 | 0.000 | 20.300 | 0.601 | 2.036 |
| | 2012 | 58 | 6.882 | 6.522 | 6.000 | 0.000 | 27.200 | 0.766 | 3.106 |
| | 2013 | 57 | 7.035 | 6.699 | 6.000 | 0.000 | 28.000 | 0.758 | 3.222 |
| | 2014 | 56 | 7.357 | 6.653 | 7.000 | 0.000 | 25.300 | 0.505 | 2.446 |

**Table 5**

Table 6 shows the descriptive statistics for the other investment by the fund. We can say judging from the statistics that the average allocation for other investment by Canadian pension funds remains stable for the period 2010-2014. The surprising observation that some funds invest more than 40 % of the funds into other categories can be attributed to 1 fund namely the Nova Scotia Healthcare employees plan as this fund has a strategy of investing much more than average into the other asset categories.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* |
|---|---|---|---|---|---|---|---|---|---|
| **Other investment %** | 2010 | 57 | 7.032 | 7.808 | 4.500 | 0.000 | 37.591 | 1.610 | 5.986 |
| | 2011 | 58 | 7.022 | 8.620 | 4.600 | 0.000 | 43.999 | 1.908 | 7.541 |
| | 2012 | 58 | 7.417 | 8.982 | 3.767 | 0.000 | 49.907 | 2.257 | 10.116 |
| | 2013 | 57 | 8.374 | 8.772 | 6.000 | 0.000 | 46.845 | 1.893 | 8.074 |
| | 2014 | 56 | 7.685 | 7.074 | 5.715 | 0.000 | 28.937 | 1.125 | 3.895 |

**Table 6**

What can be concluded from the descriptive statistics is that some funds seem to follow radically different strategies than the average fund. Some funds will invest up till 73% in equity following risky strategy while other funds go the opposite route and invest 100% in fixed income going for the safest strategy and taking on almost no risk.

Table 7 presents the correlation matrix. We can see that fixed income is significantly statistically correlated to equity and the same can be said for the variable Age.

**Correlations for the full sample 2010 – 2014.**

***Equity*:** Equity as percentage of total invested assets (%); ***FixedIncome*:** Fixed income as percentage of total invested assets (%); ***realEstate*:** Real estate as percentage of total invested assets (%); ***otherInvest*:** Other investments as percentage of total invested assets (%); ***Assets*:** Total assets (x million $); ***Size*:** Natural logarithm of total assets; ***Age*:** Pension payments scaled by total liabilities (ratio); ***FundingRatio*:** Total assets scaled by total liabilities (ratio); ***pensionPayments*** **:** Pension payments (x million $); ***Liabilities*:** Total liabilities (x million $). ***Size, Age*** and ***FundingRatio*** winsorized at the 99 percent level. *Significance levels are* $^{**}p < 0.05$, $^{***}p < 0.01$

| | *Equity* | *FixedIncome* | *realEstate* | *otherInvest* | *Assets* | *Size* | *Age* | *FundingRatio* | *Liabilities* | *pensionPayments* |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Equity*** | 1 | | | | | | | | | |
| ***FixedIncome*** | -0.570*** | 1 | | | | | | | | |
| ***realEstate*** | 0.101 | -0.385*** | 1 | | | | | | | |
| ***otherInvest*** | -0.0611 | -0.359*** | 0.0164 | 1 | | | | | | |
| ***Assets*** | -0.108 | -0.106 | 0.249*** | 0.285*** | 1 | | | | | |
| ***Size*** | -0.0289 | -0.0994 | 0.264*** | 0.219*** | 0.776*** | 1 | | | | |
| ***Age*** | -0.459*** | 0.497*** | -0.142* | -0.121* | -0.0823 | -0.0966 | 1 | | | |
| ***FundingRatio*** | -0.151** | 0.0732 | -0.0113 | 0.103 | 0.137* | 0.258*** | 0.130* | 1 | | |
| ***Liabilities*** | -0.0620 | -0.158** | 0.269*** | 0.304*** | 0.983*** | 0.766*** | -0.0914 | 0.0240 | 1 | |
| ***pensionPayments*** | -0.461*** | 0.491*** | -0.131* | -0.110 | -0.0456 | -0.0644 | 0.994*** | 0.134* | -0.0539 | 1 |

**Table 7**

## 4.4 Methodology

In this part of the thesis the methodology will be explained that will be used to test the hypotheses.

### *4.4.1 Panel data analysis*

The data for this thesis contains cross sectional data and time series data where we can observe the asset allocations and other variables over time resulting in the data set. Since the data is cross sectional and has time series data a panel data analysis would be most suited to the data. The benefit of using panel data analysis is that it allows the user to control for variables that are hard to measure or observe such as the individual characteristics of pension funds. In addition, it also allows the user to control for variables that may change over time but not across different entities (pension funds). This way, panel data accounts for any unobserved individual heterogeneity that might be present in the dataset. When utilizing panel data analysis there are two main techniques namely fixed effects analysis and random effects analysis.

Fixed effect analysis is used when you are interested in analyzing the impact of variables over time. With the fixed effects analysis, a term is added for the individual fixed effect. This means that we use the model to investigate the relationship between risk appetite and pension fund characteristics but with the fixed effects added in we also consider that each fund in the data set has its fund specific characteristics that effect this relationship (risk appetite and the variables). This means that the effect of for example size on risk appetite is separated from the own fund characteristics that affect risk appetite.

When using the fixed effects model, there are two conditions that must be met. The first condition is that when using the fixed effects model, we assume that there is something within the fund that could impact the predictor or outcome variables.

Fixed effects thus require controlling for this effect that can occur. The second assumption in the fixed effects approach is that time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics.

Each fund in the data set is different and this means that time invariant characteristics are unique to the pension fund and are not correlated with other fund characteristics.

The random effects model is different from the fixed effects model in how it regards the interaction between the individual characteristics of the pension fund and the independent variables. The random effects method assumes that the random variation is not correlated with the independent variables. The advantage of the random effects method is that it gives explanatory power to time invariant variables using the assumption that error terms are not correlated with the independent variables. When using the random effects, method two assumptions are required. The first assumption is that the observations in the panel set should be selected randomly. The second assumption requires that the unobserved explanatory variable is distributed independently from the observed ones.

The standard equation for a panel data estimation would look like this

$$Y_{i,t} = \beta 0 + \sum_{j}^{n} \beta_j X_{i,t} + \varepsilon_{i,t}$$

The $Y_{i,t}$describes the dependant variable while the $\beta 0$ is the unknown intercept for each fund in dataset. The $\beta_j$ represents the coefficient of the explanatory variable while the independent variable is $X_{i,t}$ . Finally, $\varepsilon_{i,t}$ represents the error term in this equation. The I refer to the specific fund while t refers to the time period. This is the simplest form of a panel data equation which can be extended by adding fund specific effects to the equation. The fund specific effects can not directly be observed and thus are the unobserved explanatory variable. If we add these effects to the equations the equations end up like this.

$$Y_{i,t} = \beta 0 + \sum_{j}^{n} \beta_j X_{j,i,t} + \sum_{p}^{k} \gamma_p D_{p,i} + \varepsilon_{i,t}$$

The new variables that are added to this equation are $\gamma_p$ $D_{p,i}$ and the subscript$t$. $D_{p,i}$ is the unobserved explanatory variable while yp is the coefficient of this variable. The subscript j is used to distinguish the explanatory variable while the j is for the unobserved variables. This equation allows for the inclusion of dummy variables.

We can simplify this equation by assuming that the unobserved variables do not change through the different funds. If we make this assumption we assume the unobserved variable $\propto_i$ .The equation then becomes.

$$Y_{i,t} = \beta 0 + \sum_{j}^{n} \beta_j X_{j,i,t} + \propto_i + \ \varepsilon_{i,t}$$

In this equation $\propto_i$ is the unobserved effect that stays constant for each specific fund.

*4.4.2 Model choice*

Before proceeding with any of the analysis first a decision must be made regarding which method will be used to analyse the data. Fixed effects and random effects are both models specified for certain types of data. Luckily to assist in the choice of model there is the Durban Wu Haussmann test which helps in choosing the model. Also, there are some consideration that need to be considered when choosing the model.

Clarke et al mention in their paper "The Choice Between Fixed and Random Effects Models: Some Considerations For Educational Research" that if one wants to apply the random effects model that the assumption of "observations should be randomly selected from a sample " (Clark, Crawford, Steele, & Vignoles, 2010) . In the case of this research this is clearly not the case which would lead us to believe that a fixed effects model is the best approach. To be certain that the fixed effects model is the right choice a Durban Wu and Haussmann test will be performed too.

The Durban Wu and Haussmann test is described by the following formula

$$H = (\beta fe - \ \beta re)[Var(fe) - Var(re)] - 1(\beta fe - \beta re$$

This formula uses the chi square distribution with the Var and Var indicating the number of degrees of freedom. If the probability is higher than the associated Chi^2 p value then fixed effects is the appropriate model to use in the analysis.

4.5 Haussmann test

**Table 8: Haussmann specification test.**

$\boldsymbol{Equity}$: Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$: Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$: Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$: Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$: Total assets (x million \$); $\boldsymbol{Age}$: Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$: Total assets scaled by total liabilities (ratio).
Testing difference in regression coefficients:
$b = consistent\ under\ H_0\ and\ H_a; obtained\ from\ a\ fixed\ effects\ regression$
$B = inconsistent\ under\ H_a; efficient\ under\ H_0\ obtained\ from\ a\ random\ effects\ regression$
Testing hypothesis: $H_0$: $difference\ in\ coefficients\ not\ systematic$

| | $(b)$ Fixed effects | $(B)$ Random effects | $(b-B)$ Difference | $\chi^2(2) = (b-B)'(Var_b - Var_B)^{-1}(b-B)$ |
|---|---|---|---|---|
| Dependent: $\boldsymbol{Equity}$ (%) | | | | |
| $\boldsymbol{Size}$ | 0.078 | -0.339 | 0.418 | $\chi^2(2) = 1.43$ |
| $\boldsymbol{FundingRatio}$ | 1.913 | 0.508 | 1.405 | |
| $\boldsymbol{Age}$ | -0.042 | -1.029 | 0.987 | $Prob > \chi^2 = 0.6980$ |
| Dependent: $\boldsymbol{FixedIncome}$ (%) | | | | |
| $\boldsymbol{Size}$ | 2.917 | 0.553 | 2.365 | $\chi^2(2) = 3.04$ |
| $\boldsymbol{FundingRatio}$ | -6.225 | -2.755 | -3.470 | |
| $\boldsymbol{Age}$ | 0.069 | 1.361 | -1.292 | $Prob > \chi^2 = 0.3857$ |
| Dependent: $\boldsymbol{realEstate}$ (%) | | | | |
| $\boldsymbol{Size}$ | 1.653 | 1.608 | 0.045 | $\chi^2(2) = 0.17$ |
| $\boldsymbol{FundingRatio}$ | -0.843 | -0.962 | 0.119 | |
| $\boldsymbol{Age}$ | -0.056 | -0.109 | 0.053 | $Prob > \chi^2 = 0.9822$ |
| Dependent: $\boldsymbol{otherInvest}$ (%) | | | | |
| $\boldsymbol{Size}$ | -2.083 | -0.450 | -1.632 | $\chi^2(2) = 6.58$ |
| $\boldsymbol{FundingRatio}$ | 6.627 | 4.527 | 2.100 | |
| $\boldsymbol{Age}$ | -0.267 | -0.196 | -0.070 | $Prob > \chi^2 = 0.0866$ |

The results mention that the most suitable technique to explain the Equity (as dependent variable), is the random effects panel regression since $H_0$ of randomness of the variables could not be rejected ($Prob > \chi^2 = 0.6980$). The same conclusion can be drawn for the fixed income, real estate and other fund investments with respectively $Prob > \chi^2 = 0.3857$, $Prob > \chi^2 = 0.9822$, and $Prob > \chi^2 = 0.0866$.

## 4.5 Hypotheses tested

Before proceeding with the analysis of the hypotheses tested the hypothesis are presented once more:

- **Hypothesis 1**: The Size of Canadian pension funds is positively related to the Equity share of the pension fund.

- **Hypothesis 2**: the average age of the fund has effect on the equity share

- **Hypothesis 3**: High funding levels translate to higher equity shares in the portfolio

# Chapter 5 Empirical Results

This table presents random effects regression coefficients and standard errors. Dependent variables are denoted in each column. $\boldsymbol{Equity}$**:** Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$**:** Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$**:** Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$**:** Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$**:** Natural logarithm of total assets; $\boldsymbol{Age}$**:** Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$**:** Total assets scaled by total liabilities (ratio). Data winsorized at the 99 percent level. Robust standard errors are shown between parentheses. ***, **, * indicate significance at 1, 5, and 10% levels, respectively.

| *Specification:* | (1) | (2) | (3) |
|---|---|---|---|
| *Dependent:* | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ |
| *Independents:* | | | |
| $\boldsymbol{Size}$ | 0.0113 | 0.0818 | -0.3399 |
| | (1.1240) | (1.2383) | (1.1942) |
| $\boldsymbol{FundingRatio}$ | | -0.6739 | 0.5076 |
| | | (3.0864) | (2.7940) |
| $\boldsymbol{Age}$ | | | -1.0294*** |
| | | | (0.0433) |
| Constant | 46.8213*** | 46.8447*** | 50.3723*** |
| | (9.9669) | (10.0678) | (9.9216) |
| Observations | 290 | 289 | 284 |
| R-squared | 0.0003 | 0.0010 | 0.0000 |
| Number of id | 59 | 59 | 58 |
| Overall R-squared | 0.0008 | 0.0163 | 0.2127 |
| Wald chi2-statistic | 0.0001 | 0.0487 | 1041.7287 |
| p(chi2) | 1.0000 | 1.0000 | 0.0000 |

**Table 9**

Our Haussmann test indicated that we only should look at the random effects regression and should not consider the fixed effects regression. Table7 above contains the results for the random effects regression. The table shows the dependent variables and the independent in every possible combination. Before we take a closer look at the results we first should consider the fit of the model that has been used. The variable we use to assess the fit of the model is R squared value. A high R squared indicates that the model´s variables do a good of the predicting the outcome variable. For our first hypothesis, we theorized that the size of Canadian pension funds would be positively related to equity allocation of the fund. When we add the size variable to our model of which we can see the results in table 14. In model with the Size variable the R squared of the model is a low R-squared of 0.0008. When the funding variable is added we arrive at an R squared of the model at 0.0163 meaning that the model can only explain 1.63% of the variation in the model. When we add the last variable Age, we get an R-squared of the model at 0.2127 meaning that the model can explain 21 % of the observed variation in the model.

We first focus on the dependent variable of Equity. We ran three regressions with Equity as dependent variable and stepwise added the three independent variables of Size, Funding ratio and Age. When we only add size to the model we find insignificant results. The size variable is not significant. This finding contrasts with the papers from Bikkers and Dreu from 2012 in which the authors do find a significant positive relationship between Size of the pension fund and the Equity share of that fund. The model is then extended by adding the Funding ratio variable. This does not have any significant effect as the coefficients for Size and funding ratio remain insignificant which in contrast to the Alestalo paper and the Rauh paper which both find significant positive results for the funding ratio variable. When the third independent variable in inserted into the model we find significant results. The coefficient for age (-1.0294) is significant at the 1, 5, 10% levels. This means that for every 1 increase in the variable age (pension payments scaled by total liabilities) the percentage total equity goes down by -1.0294 percent. This seems to confirm the third hypothesis that as the average age in the fund goes up, pension's funds shift their asset allocations to less risky stocks. This finding is in line with the results of the Alestalo et al, Bikker et al and the Gerber et al paper. These authors all found significant results for their age variable all indicating that as average age of the constituents in the fund goes up the equity share in the fund goes down.

We can thus only find evidence for the 3rd hypothesis as the other two variables do not have significant variables. We also run the regression with fixed income, real-estate and other investment as dependent variable. The variable Age remains significant in all three other regressions. What is interesting to note is that when real estate as dependent variable the variable size becomes significant at the 1,5,10 % levels. These results can all be found in table 14. This is surprising because we expected the size variable to significant for the dependent variable Equity in accordance with our predicted hypothesis, instead we find a significant result with real estate as the dependant variable.

Reasons for the insignificance of the factors can be due to multiple reasons. Firstly, the data set is very limited, the data set only covers 5 years of the Canadian pension market and covers around 70 funds. This leads to limited data set in which market disruptions can have profound effects. The dataset contains the economic crisis period and the fallout afterwards. The crisis led to falling equity prices together with shifts in government bond prices must have affected the asset allocation and risk appetite. Also, worth noting is that the funding ratio is dependent on the amount of liabilities which in turn is influenced by the discount rate the pension fund uses. Discount rates have gown during the period of our sample leading to a possible bias.

Ultimately the main reason for the current findings is the data set. The previously mentioned papers by Bikkers, Putaloo and Weber all used databases that were provided by the financial watch dog of their respective countries. These papers thus used very accurate and rich databases without missing any observations or funds. Other papers for example by de Ronde (Ronde, n.d.) which also used data from the annual reports of German pension funds also found the variables to be not significant .

## Chapter 6 Conclusion

The late international financial crisis impacted financial markets all over the world. Pension funds fair asset value were especially affected by the crisis. The equity market was hit hard, while the bond market suffered a drop too. These two-combined created for extreme losses for pension funds in the Canadian market). On top of volatile markets, the Canadian pension sector faces the same problem that can be found in the rest of the modernized world, namely an aging population with an increasing birth deficit further straining the system. These arguments show that it would be insightful in what drives the risk appetite of Canadian pension funds or i.e., what drives their equity allocation.

Canadian pension funds all are privately run funds, and they differ in their portfolio strategy, some funds will choose to allocate les/more to certain asset categories creating for variation in fund portfolios. Especially the equity portion tends to fluctuate from fund to fund as each fund has its own risk appetite. We came up with three variables on factors that could influence the risk appetite of the funds. One of the variables is linked to the life cycle theory, while the other two variables are linked to existing research.

We find significant results for the age variable when taking equity as dependent variable. Confirming our third hypothesis. We do not find significant results for the other two variables. When we take real estate as dependent variable, we do find that the size coefficient is significant. The results thus do support our third hypothesis and not the first two.

The initial thought behind the approach was to test whether certain fund characteristics would influence the equity allocation of the fund. However, after running the panel data analysis, only the factor for age was found to be significant.

Reasons for the insignificance of the factors can be due to multiple reasons. Firstly, the data set is very limited, the data set only covers 5 years of the Canadian pension market and covers around 70 funds. This leads to limited data set in which market disruptions can have profound effects. The dataset contains the economic crisis period and the fallout afterwards. The crisis led to falling equity prices together with shifts in government bond prices must have affected the asset allocation and risk appetite. Also, worth noting is that the funding ratio is dependent on the amount of liabilities which in turn is influenced by the discount rate the pension fund uses. Discount rates have gown during the period of our sample leading to a possible bias. Ultimately the main reason for the current findings is the data set. The previously mentioned papers by Bikkers, Putaloo and Weber all used databases that were provided by the financial watch dog of their respective countries. These papers thus used very accurate and rich databases without missing any observations or funds. Other papers for example by de Ronde (Ronde, n.d.) which also used data from the annual reports of German pension funds also found the variables to be not significant

The insignificance is caused by the dataset. The dataset was manually gathered from the 100 biggest Canadian pension funds leading to a data set of 70 funds. Then the sample period also contains a financial crisis and its remnants in the years that followed. Secondly the data from the annual reports is not all conclusive, some funds were missing data for specific years and even when contacted would not respond to the request for data. Also, consequences of the financial crisis play a part in the data set through indirect ways (discount rate) that could affect the results. Concluding the results, it can be said that it is disappointing that the analysis did not turn into any significant results and the main culprit for this can be found in the data.

## Chapter 7 Recommendations for Future Research

The recommendation for future research on this topic would be simple, better data. Simply put, better data leads to better results and better research. Future research should look at the Canadian superintendent of financial services that has an accurate yearly updated database of Canadian pension funds holdings. This database is much more detailed and spans all of the Canadian pension funds and not only the 100 biggest. Access to this database is restricted for now, but maybe future researchers will be able to gain access.

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## Appendix

**Table 10: Summary Statistics for the full sample 2010 – 2014.**

$\boldsymbol{Equity}$: Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$: Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$: Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$: Other investments as percentage of total invested assets (%); $\boldsymbol{Assets}$: Total assets (x million $); ***Size***: Natural logarithm of total assets; $\boldsymbol{Age}$: Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$: Total assets scaled by total liabilities (ratio); $\boldsymbol{pensionPayments}$ : Pension payments (x million $); $\boldsymbol{Liabilities}$: Total liabilities (x million $). ***Size,*** $\boldsymbol{Age}$ and $\boldsymbol{FundingRatio}$ winsorized at the 99 percent level. $p10$,$p25$,$p75$, and $p90$ are respectively $10^{th}$, $25^{th}$, $75^{th}$, and $90^{th}$ percentiles.

| | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* | *p10* | *p25* | *p75* | *p90* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\boldsymbol{Equity}$ **(%)** | 291 | 46.855 | 13.915 | 49.000 | 0.000 | 73.000 | -1.303 | 5.358 | 31.774 | 40.000 | 57.000 | 61.000 |
| $\boldsymbol{FixedIncome}$ **(%)** | 291 | 38.189 | 16.788 | 34.521 | 0.000 | 100.000 | 0.956 | 5.437 | 23.600 | 28.000 | 46.700 | 60.000 |
| $\boldsymbol{realEstate}$ **(%)** | 286 | 6.444 | 6.258 | 5.572 | 0.000 | 28.000 | 0.687 | 2.825 | 0.000 | 0.000 | 11.300 | 15.100 |
| $\boldsymbol{otherInvest}$ **(%)** | 286 | 7.503 | 8.246 | 4.935 | 0.000 | 49.907 | 1.863 | 7.957 | 0.000 | 1.200 | 11.400 | 17.200 |
| $\boldsymbol{Assets}$ | 293 | 9159.443 | 11127.895 | 5078.000 | 76.966 | 72096.000 | 2.855 | 12.946 | 1492.000 | 2628.000 | 12407.000 | 19685.069 |
| ***Size*** | 293 | 8.550 | 1.150 | 8.533 | 4.343 | 11.186 | -0.551 | 4.234 | 7.308 | 7.874 | 9.426 | 9.888 |
| $\boldsymbol{Age}$ | 287 | 0.857 | 6.080 | 0.047 | 0.015 | 47.035 | 7.384 | 55.559 | 0.033 | 0.039 | 0.057 | 0.071 |
| $\boldsymbol{FundingRatio}$ | 292 | 0.918 | 0.217 | 0.917 | 0.093 | 1.955 | 0.340 | 10.296 | 0.730 | 0.822 | 1.014 | 1.097 |
| $\boldsymbol{Liabilities}$ | 292 | 9877.470 | 11501.080 | 5832.148 | 116.427 | 79174.000 | 2.939 | 14.541 | 1634.000 | 3112.907 | 13644.000 | 20995.000 |
| $\boldsymbol{pensionPayments}$ | 288 | 2069.842 | 12188.639 | 291.086 | 1.700 | 108086.000 | 7.523 | 58.426 | 73.000 | 143.814 | 786.348 | 1085.000 |

**Table 11: Summary Statistics of the asset allocations per year.**

***Equity*****:** Equity as percentage of total invested assets (%);***FixedIncome*****:** Fixed income as percentage of total invested assets (%); ***realEstate*****:** Real estate as percentage of total invested assets (%); ***otherInvest*****:** Other investments as percentage of total invested assets (%). $p10$ and $p90$ are respectively $10^{th}$ and $90^{th}$ percentiles.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* | *p10* | *p90* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 58 | 48.528 | 13.638 | 49.600 | 0.000 | 67.000 | -1.811 | 7.123 | 35.955 | 62.400 |
| | 2011 | 59 | 45.729 | 14.765 | 47.900 | 0.000 | 71.400 | -1.460 | 5.791 | 31.600 | 62.300 |
| ***Equity*** **(%)** | 2012 | 59 | 47.423 | 12.382 | 49.181 | 0.000 | 68.000 | -1.168 | 5.559 | 31.800 | 59.800 |
| | 2013 | 58 | 47.831 | 13.924 | 50.350 | 0.000 | 73.000 | -0.916 | 4.221 | 32.947 | 63.600 |
| | 2014 | 57 | 44.737 | 14.877 | 49.000 | 0.000 | 67.900 | -1.084 | 4.156 | 28.000 | 60.900 |
| | 2010 | 58 | 37.606 | 15.672 | 34.400 | 0.000 | 100.000 | 1.233 | 7.461 | 25.200 | 55.000 |
| | 2011 | 59 | 38.460 | 16.621 | 36.226 | 0.000 | 100.000 | 0.710 | 5.997 | 25.000 | 60.000 |
| ***FixedIncome*** **(%)** | 2012 | 59 | 38.423 | 16.462 | 35.000 | 0.000 | 100.000 | 1.093 | 5.608 | 23.000 | 60.000 |
| | 2013 | 58 | 37.429 | 17.407 | 32.100 | 0.000 | 100.000 | 1.041 | 4.704 | 20.100 | 59.000 |
| | 2014 | 57 | 39.035 | 18.234 | 35.500 | 0.000 | 100.000 | 0.761 | 4.255 | 21.000 | 62.000 |
| | 2010 | 57 | 5.212 | 5.348 | 4.360 | 0.000 | 15.600 | 0.464 | 1.725 | 0.000 | 13.600 |
| | 2011 | 58 | 5.755 | 5.917 | 3.850 | 0.000 | 20.300 | 0.601 | 2.036 | 0.000 | 15.100 |
| ***realEstate*** **(%)** | 2012 | 58 | 6.882 | 6.522 | 6.000 | 0.000 | 27.200 | 0.766 | 3.106 | 0.000 | 15.400 |
| | 2013 | 57 | 7.035 | 6.699 | 6.000 | 0.000 | 28.000 | 0.758 | 3.222 | 0.000 | 15.400 |
| | 2014 | 56 | 7.357 | 6.653 | 7.000 | 0.000 | 25.300 | 0.505 | 2.446 | 0.000 | 15.207 |
| | 2010 | 57 | 7.032 | 7.808 | 4.500 | 0.000 | 37.591 | 1.610 | 5.986 | 0.000 | 17.200 |
| | 2011 | 58 | 7.022 | 8.620 | 4.600 | 0.000 | 43.999 | 1.908 | 7.541 | 0.000 | 18.543 |
| ***otherInvest*** **(%)** | 2012 | 58 | 7.417 | 8.982 | 3.767 | 0.000 | 49.907 | 2.257 | 10.116 | 0.000 | 15.600 |
| | 2013 | 57 | 8.374 | 8.772 | 6.000 | 0.000 | 46.845 | 1.893 | 8.074 | 0.000 | 18.000 |
| | 2014 | 56 | 7.685 | 7.074 | 5.715 | 0.000 | 28.937 | 1.125 | 3.895 | 0.000 | 17.070 |

**Table 12: Summary Statistics of the asset allocations per year.**

$\boldsymbol{Size}$: Natural logarithm of total assets; $\boldsymbol{Age}$: Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$: Total assets scaled by total liabilities (ratio); $\boldsymbol{pensionPayments}$ : Pension payments (x million $); $\boldsymbol{Liabilities}$: Total liabilities (x million $). ***Size, Age*** and $\boldsymbol{FundingRatio}$ winsorized at the 99 percent level. $p10$ and $p90$ are respectively 10th and 90th percentiles.

| | *Year* | *Obs* | *Mean* | *St.dev.* | *Median* | *Min* | *Max* | *Skewness* | *Kurtosis* | *p10* | *p90* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 59 | 8.391 | 1.161 | 8.348 | 4.343 | 10.885 | -0.625 | 4.416 | 7.176 | 9.743 |
| | 2011 | 59 | 8.429 | 1.162 | 8.451 | 4.465 | 10.917 | -0.567 | 4.218 | 7.190 | 9.757 |
| $\boldsymbol{Size}$ | 2012 | 59 | 8.521 | 1.166 | 8.516 | 4.641 | 11.015 | -0.519 | 3.996 | 7.270 | 9.852 |
| | 2013 | 59 | 8.666 | 1.092 | 8.611 | 4.827 | 11.016 | -0.468 | 4.350 | 7.495 | 9.948 |
| | 2014 | 57 | 8.743 | 1.160 | 8.726 | 4.948 | 11.016 | -0.637 | 4.253 | 7.631 | 10.030 |
| | 2010 | 57 | 0.872 | 6.211 | 0.049 | 0.015 | 46.941 | 7.350 | 55.017 | 0.032 | 0.073 |
| | 2011 | 58 | 0.808 | 5.782 | 0.046 | 0.018 | 44.081 | 7.417 | 56.017 | 0.033 | 0.078 |
| $\boldsymbol{Age}$ | 2012 | 58 | 0.858 | 6.170 | 0.045 | 0.020 | 47.035 | 7.417 | 56.017 | 0.034 | 0.068 |
| | 2013 | 58 | 0.860 | 6.170 | 0.048 | 0.027 | 47.035 | 7.417 | 56.017 | 0.036 | 0.073 |
| | 2014 | 56 | 0.887 | 6.279 | 0.045 | 0.027 | 47.035 | 7.281 | 54.018 | 0.033 | 0.071 |
| | 2010 | 58 | 0.913 | 0.213 | 0.931 | 0.195 | 1.955 | 1.197 | 13.028 | 0.691 | 1.072 |
| | 2011 | 59 | 0.887 | 0.223 | 0.876 | 0.165 | 1.955 | 1.350 | 11.950 | 0.676 | 1.048 |
| $\boldsymbol{FundingRatio}$ | 2012 | 59 | 0.895 | 0.228 | 0.871 | 0.124 | 1.955 | 1.174 | 11.154 | 0.708 | 1.114 |
| | 2013 | 59 | 0.960 | 0.194 | 0.968 | 0.110 | 1.652 | -0.769 | 10.198 | 0.809 | 1.148 |
| | 2014 | 57 | 0.937 | 0.227 | 0.944 | 0.093 | 1.532 | -1.378 | 8.298 | 0.773 | 1.122 |
| | 2010 | 58 | 8383.305 | 9832.430 | 4917.500 | 116.427 | 57816.000 | 2.773 | 12.914 | 1350.000 | 18373.784 |
| | 2011 | 59 | 9126.000 | 10510.123 | 5150.000 | 140.145 | 62373.000 | 2.744 | 12.940 | 1462.168 | 19110.000 |
| $\boldsymbol{Liabilities}$ | 2012 | 59 | 9993.495 | 11691.324 | 5913.000 | 155.193 | 70691.000 | 2.877 | 13.990 | 1544.639 | 20995.000 |
| | 2013 | 59 | 10330.808 | 12082.654 | 6081.931 | 136.944 | 73722.000 | 2.994 | 14.627 | 1903.000 | 21132.000 |
| | 2014 | 57 | 11586.346 | 13253.768 | 7192.000 | 157.768 | 79174.000 | 2.886 | 13.711 | 2297.967 | 22695.000 |
| | 2010 | 58 | 445.681 | 525.404 | 256.500 | 1.700 | 3100.000 | 2.737 | 12.996 | 51.000 | 1045.000 |
| | 2011 | 58 | 473.096 | 539.945 | 274.500 | 2.458 | 3100.000 | 2.571 | 11.684 | 54.000 | 1048.000 |
| $\boldsymbol{pensionPayments}$ | 2012 | 58 | 508.474 | 575.349 | 295.000 | 3.118 | 3100.000 | 2.388 | 10.035 | 64.000 | 1104.837 |
| | 2013 | 58 | 547.215 | 612.733 | 325.000 | 3.630 | 3100.000 | 2.377 | 9.675 | 83.000 | 1165.000 |
| | 2014 | 56 | 578.185 | 635.792 | 344.792 | 4.300 | 3100.000 | 2.396 | 9.612 | 102.000 | 1153.000 |

Table 13**: Correlations for the full sample 2010 – 2014.**

***Equity*****:** Equity as percentage of total invested assets (%); ***FixedIncome*****:** Fixed income as percentage of total invested assets (%); ***realEstate*****:** Real estate as percentage of total invested assets (%); ***otherInvest*****:** Other investments as percentage of total invested assets (%); ***Assets*****:** Total assets (x million $); ***Size*****:** Natural logarithm of total assets; ***Age*****:** Pension payments scaled by total liabilities (ratio); ***FundingRatio*****:** Total assets scaled by total liabilities (ratio); ***pensionPayments*** **:** Pension payments (x million $); ***Liabilities*****:** Total liabilities (x million $). ***Size, Age*** and ***FundingRatio*** winsorized at the 99 percent level. *Significance levels are* $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

| | ***Equity*** | ***FixedIncome*** | ***realEstate*** | ***otherInvest*** | ***Assets*** | ***Size*** | ***Age*** | ***FundingRatio*** | ***Liabilities*** | ***pensionPayments*** |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Equity*** | 1 | | | | | | | | | |
| ***FixedIncome*** | -0.570$^{***}$ | 1 | | | | | | | | |
| ***realEstate*** | 0.101 | -0.385$^{***}$ | 1 | | | | | | | |
| ***otherInvest*** | -0.0611 | -0.359$^{***}$ | 0.0164 | 1 | | | | | | |
| ***Assets*** | -0.108 | -0.106 | 0.249$^{***}$ | 0.285$^{***}$ | 1 | | | | | |
| ***Size*** | -0.0289 | -0.0994 | 0.264$^{***}$ | 0.219$^{***}$ | 0.776$^{***}$ | 1 | | | | |
| ***Age*** | -0.459$^{***}$ | 0.497$^{***}$ | -0.142$^{*}$ | -0.121$^{*}$ | -0.0823 | -0.0966 | 1 | | | |
| ***FundingRatio*** | -0.151$^{**}$ | 0.0732 | -0.0113 | 0.103 | 0.137$^{*}$ | 0.258$^{***}$ | 0.130$^{*}$ | 1 | | |
| ***Liabilities*** | -0.0620 | -0.158$^{**}$ | 0.269$^{***}$ | 0.304$^{***}$ | 0.983$^{***}$ | 0.766$^{***}$ | -0.0914 | 0.0240 | 1 | |
| ***pensionPayments*** | -0.461$^{***}$ | 0.491$^{***}$ | -0.131$^{*}$ | -0.110 | -0.0456 | -0.0644 | 0.994$^{***}$ | 0.134$^{*}$ | -0.0539 | 1 |

**Table 14: Hausman specification test.**

| | | | | |
|---|---|---|---|---|
| $\boldsymbol{Equity}$: Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$: Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$: Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$: Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$: Total assets (x million \$); $\boldsymbol{Age}$: Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$: Total assets scaled by total liabilities (ratio). Testing difference in regression coefficients: $b = consistent\ under\ H_0\ and\ H_a; obtained\ from\ a\ fixed\ effects\ regression$ $B = inconsistent\ under\ H_a; efficient\ under\ H_0\ obtained\ from\ a\ random\ effects\ regression$ Testing hypothesis: $H_0$: $difference\ in\ coefficients\ not\ systematic$ | | | | |
| | $(b)$ Fixed effects | $(B)$ Random effects | $(b-B)$ Difference | $\chi^2(2) = (b-B)'(Var_b - Var_B)^{-1}(b-B)$ |
| Dependent: $\boldsymbol{Equity}$ (%) | | | | |
| $\boldsymbol{Size}$ | 0.078 | -0.339 | 0.418 | $\chi^2(2) = 1.43$ |
| $\boldsymbol{FundingRatio}$ | 1.913 | 0.508 | 1.405 | |
| $\boldsymbol{Age}$ | -0.042 | -1.029 | 0.987 | $Prob > \chi^2 = 0.6980$ |
| Dependent: $\boldsymbol{FixedIncome}$ (%) | | | | |
| $\boldsymbol{Size}$ | 2.917 | 0.553 | 2.365 | $\chi^2(2) = 3.04$ |
| $\boldsymbol{FundingRatio}$ | -6.225 | -2.755 | -3.470 | |
| $\boldsymbol{Age}$ | 0.069 | 1.361 | -1.292 | $Prob > \chi^2 = 0.3857$ |
| Dependent: $\boldsymbol{realEstate}$ (%) | | | | |
| $\boldsymbol{Size}$ | 1.653 | 1.608 | 0.045 | $\chi^2(2) = 0.17$ |
| $\boldsymbol{FundingRatio}$ | -0.843 | -0.962 | 0.119 | |
| $\boldsymbol{Age}$ | -0.056 | -0.109 | 0.053 | $Prob > \chi^2 = 0.9822$ |
| Dependent: $\boldsymbol{otherInvest}$ (%) | | | | |
| $\boldsymbol{Size}$ | -2.083 | -0.450 | -1.632 | $\chi^2(2) = 6.58$ |
| $\boldsymbol{FundingRatio}$ | 6.627 | 4.527 | 2.100 | |
| $\boldsymbol{Age}$ | -0.267 | -0.196 | -0.070 | $Prob > \chi^2 = 0.0866$ |

The results mention that the most suitable technique to explain the Equity (as dependent variable), is the random effects panel regression since $H_0$ of randomness of the variables could not be rejected ($Prob > \chi^2 = 0.6980$). The same conclusion can be drawn for the fixed income, real estate and other fund investments with respectively $Prob > \chi^2 = 0.3857$, $Prob > \chi^2 = 0.9822$, and $Prob > \chi^2 = 0.086$

**Table 15: Fixed effects regression. Effect of size, age and funding ratio on pension funds' risk appetite. It includes the outcome variable, the constant, the observed and unobserved explanatory variables, their coefficients and their standard errors.**

This table presents fixed effects regression coefficients and standard errors. Dependent variables are denoted in each column. $\boldsymbol{Equity}$**:** Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$**:** Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$**:** Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$**:** Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$**:** Natural logarithm of total assets; $\boldsymbol{Age}$**:** Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$**:** Total assets scaled by total liabilities (ratio). Data winsorized at the 99 percent level. Robust standard errors are shown between parentheses. ***, **, * indicate significance at 1, 5, and 10% levels, respectively.

| *Specification:* | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dependent:* | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ |
| *Independents:* | | | | | | | | | | | | |
| $\boldsymbol{Size}$ | 0.4126 | -0.0495 | 0.0781 | 1.8828 | 3.3862 | 2.9172 | 1.4794 | 1.6387 | 1.6532 | -0.5105 | -1.8895 | -2.0830 |
| | (1.4576) | (1.6953) | (1.7071) | (2.2048) | (2.0693) | (2.1938) | (0.9553) | (1.0679) | (1.0868) | (2.2863) | (2.3628) | (2.2840) |
| $\boldsymbol{FundingRatio}$ | | 2.0806 | 1.9131 | | -6.7545 | -6.2247 | | -0.8324 | -0.8428 | | 6.3242** | 6.6269** |
| | | (3.6597) | (3.7089) | | (4.1918) | (4.2977) | | (2.0325) | (2.0642) | | (3.1216) | (3.0980) |
| $\boldsymbol{Age}$ | | | -0.0422 | | | 0.0694 | | | -0.0557 | | | -0.2666** |
| | | | (0.1875) | | | (0.2220) | | | (0.1005) | | | (0.1150) |
| Constant | 43.4909*** | 45.5265*** | 44.7704*** | 22.2303 | 15.6278 | 18.8652 | -6.2017 | -6.8170 | -6.7508 | 11.9012 | 17.8888 | 19.3264 |
| | (12.4565) | (13.1126) | (13.1125) | (18.8421) | (16.5315) | (17.3535) | (8.1804) | (8.5569) | (8.6608) | (19.5783) | (17.9413) | (17.2965) |
| Observations | 290 | 289 | 284 | 290 | 289 | 284 | 285 | 284 | 279 | 285 | 284 | 279 |
| R-squared | 0.000 | 0.001 | 0.001 | 0.006 | 0.014 | 0.012 | 0.031 | 0.031 | 0.032 | 0.002 | 0.034 | 0.039 |
| Number of id | 59 | 59 | 58 | 59 | 59 | 58 | 58 | 58 | 57 | 58 | 58 | 57 |
| Overall R-squared | 0.0008 | 0.0230 | 0.0114 | 0.0099 | 0.0167 | 0.0059 | 0.0698 | 0.0719 | 0.0874 | 0.0479 | 0.0218 | 0.0037 |
| F-statistic | 0.0801 | 0.2059 | 0.2893 | 0.7293 | 1.8885 | 0.9558 | 2.3983 | 1.2040 | 0.9292 | 0.0499 | 3.2074 | 2.3851 |
| p(F) | 0.7782 | 0.8145 | 0.8329 | 0.3966 | 0.1605 | 0.4199 | 0.1270 | 0.3075 | 0.4327 | 0.8241 | 0.0479 | 0.0788 |

Table 16: Least squares dummy variable regressions. Effect of size, age and funding ratio on pension funds' risk appetite. It includes the outcome variable, the constant, the observed and unobserved explanatory variables, their coefficients and their standard errors.

This table presents least squares dummy variable regression coefficients and standard errors. Dependent variables are denoted in each column. $\boldsymbol{Equity}$**:** Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$**:** Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$**:** Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$**:** Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$**:** Natural logarithm of total assets; $\boldsymbol{Age}$**:** Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$**:** Total assets scaled by total liabilities (ratio). Data winsorized at the 99 percent level. Robust standard errors are shown between parentheses. ***, **, * indicate significance at 1, 5, and 10% levels, respectively.

| *Specification:* | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dependent:* | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ |
| $\boldsymbol{Size}$ | 4.847*** | 5.163*** | 5.159*** | 5.077*** | 5.768*** | 5.747*** | -0.151*** | -0.172 | -0.173 | 0.551* | 0.205 | 0.196 |
| | (0.441) | (0.656) | (0.660) | (0.156) | (0.374) | (0.375) | (0.056) | (0.117) | (0.118) | (0.289) | (0.339) | (0.341) |
| $\boldsymbol{FundingRatio}$ | | -3.232 | -3.228 | | -7.330** | -6.963** | | 0.225 | 0.235 | | 3.641** | 3.814** |
| | | (5.265) | (5.301) | | (3.407) | (3.406) | | (1.034) | (1.043) | | (1.660) | (1.655) |
| $\boldsymbol{Age}$ | | | -0.369 | | | 0.275 | | | -0.325* | | | -0.440** |
| | | | (0.510) | | | (0.461) | | | (0.192) | | | (0.215) |
| Fund dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 290 | 289 | 284 | 290 | 289 | 284 | 285 | 284 | 279 | 285 | 284 | 279 |
| R-squared | 0.989 | 0.989 | 0.988 | 0.982 | 0.983 | 0.983 | 0.965 | 0.965 | 0.965 | 0.946 | 0.947 | 0.945 |
| adj. R-squared | 0.985 | 0.985 | 0.985 | 0.977 | 0.978 | 0.978 | 0.955 | 0.955 | 0.955 | 0.931 | 0.932 | 0.929 |
| F-statistic | 2937.913 | 2926.006 | 2840.271 | 1798.382 | 1775.659 | 8172.852 | 393.560 | 366.084 | 352.869 | 159.504 | 168.985 | 162.549 |
| p(F) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

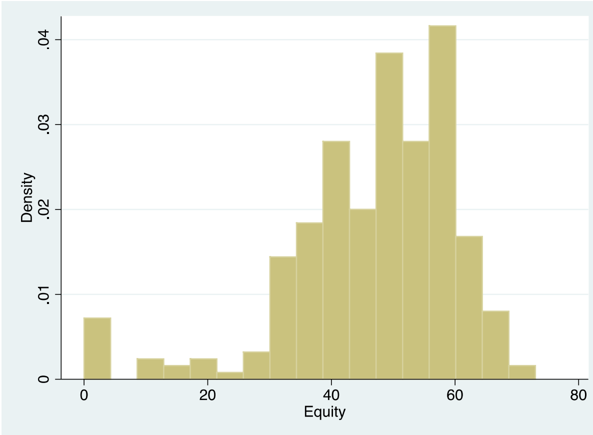
**Table 17: Random effects regression. Effect of size, age and funding ratio on pension funds' risk appetite. It includes the outcome variable, the constant, the observed and unobserved explanatory variables, their coefficients and their standard errors.**

This table presents random effects regression coefficients and standard errors. Dependent variables are denoted in each column. $\boldsymbol{Equity}$**:** Equity as percentage of total invested assets (%); $\boldsymbol{FixedIncome}$**:** Fixed income as percentage of total invested assets (%); $\boldsymbol{realEstate}$**:** Real estate as percentage of total invested assets (%); $\boldsymbol{otherInvest}$**:** Other investments as percentage of total invested assets (%); $\boldsymbol{Size}$**:** Natural logarithm of total assets; $\boldsymbol{Age}$**:** Pension payments scaled by total liabilities (ratio); $\boldsymbol{FundingRatio}$**:** Total assets scaled by total liabilities (ratio). Data winsorized at the 99 percent level. Robust standard errors are shown between parentheses. ***, **, * indicate significance at 1, 5, and 10% levels, respectively.

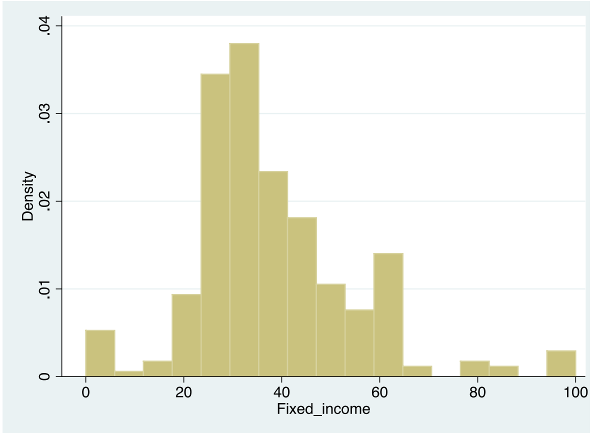
| *Specification:* | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dependent:* | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{Equity}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{FixedIncome}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{realEstate}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ | $\boldsymbol{otherInvest}$ |
| *Independents:* | | | | | | | | | | | | |
| $\boldsymbol{Size}$ | 0.0113 | 0.0818 | -0.3399 | 0.3064 | 0.5876 | 0.5526 | 1.4677** | 1.6138*** | 1.6079*** | 0.3859 | -0.2471 | -0.4505 |
| | (1.1240) | (1.2383) | (1.1942) | (1.7456) | (1.9057) | (1.7606) | (0.6129) | (0.6098) | (0.6097) | (1.6700) | (1.8342) | (1.8125) |
| $\boldsymbol{FundingRatio}$ | | -0.6739 | 0.5076 | | -1.8120 | -2.7546 | | -1.0540 | -0.9622 | | 4.1504* | 4.5266* |
| | | (3.0864) | (2.7940) | | (3.9829) | (3.6909) | | (1.7256) | (1.7512) | | (2.3179) | (2.3510) |
| $\boldsymbol{Age}$ | | | -1.0294*** | | | 1.3614*** | | | -0.1086*** | | | -0.1962*** |
| | | | (0.0433) | | | (0.0421) | | | (0.0207) | | | (0.0485) |
| Constant | 46.8213*** | 46.8447*** | 50.3723*** | 35.6786** | 34.9196** | 34.6889*** | -6.0847 | -6.3626 | -6.1730 | 4.3568 | 5.9735 | 7.3843 |
| | (9.9669) | (10.0678) | (9.9216) | (14.4775) | (14.5132) | (13.2955) | (5.1098) | (4.9995) | (4.9934) | (14.3552) | (14.3019) | (14.1060) |
| Observations | 290 | 289 | 284 | 290 | 289 | 284 | 285 | 284 | 279 | 285 | 284 | 279 |
| R-squared | 0.0003 | 0.0010 | 0.0000 | 0.0057 | 0.0124 | 0.0035 | 0.0309 | 0.0312 | 0.0315 | 0.0019 | 0.0210 | 0.0260 |
| Number of id | 59 | 59 | 58 | 59 | 59 | 58 | 58 | 58 | 57 | 58 | 58 | 57 |
| Overall R-squared | 0.0008 | 0.0163 | 0.2127 | 0.0099 | 0.0191 | 0.2403 | 0.0698 | 0.0727 | 0.0912 | 0.0479 | 0.0013 | 0.0091 |
| Wald chi2-statistic | 0.0001 | 0.0487 | 1041.7287 | 0.0308 | 0.2194 | 1584.2172 | 5.7351 | 7.0096 | 77.1121 | 0.0534 | 5.9752 | 52.3150 |
| p(chi2) | 1.0000 | 1.0000 | 0.0000 | 1.0000 | 0.9989 | 0.0000 | 0.3329 | 0.2199 | 0.0000 | 1.0000 | 0.3086 | 0.0000 |

**Figure 6: Distribution of the regression variables.**

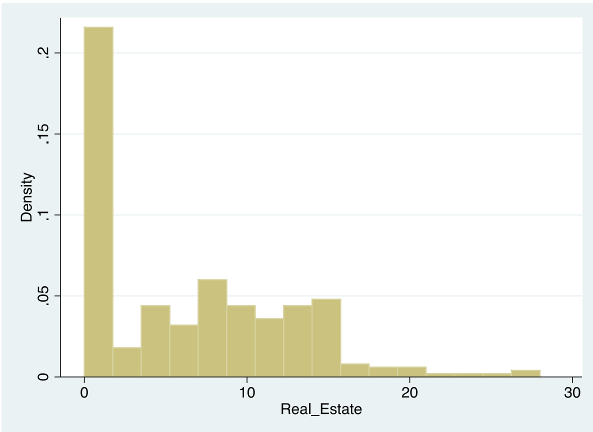
***Equity*:** Equity as percentage of total invested assets (%); ***FixedIncome*:** Fixed income as percentage of total invested assets (%); ***realEstate*:** Real estate as percentage of total invested assets (%); ***otherInvest*:** Other investments as percentage of total invested assets (%); ***Size*:** Natural logarithm of total assets; ***Age*:** Pension payments scaled by total liabilities (ratio); ***FundingRatio*:** Total assets scaled by total liabilities (ratio); ***pensionPayments* :** Pension payments (x million $); ***Liabilities*:** Total liabilities (x million $). ***Size, Age*** and ***FundingRatio*** winsorized at the 99 percent level.



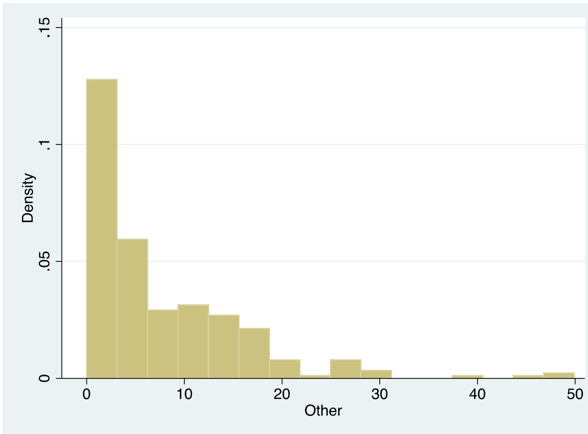

Panel A: *Equity*



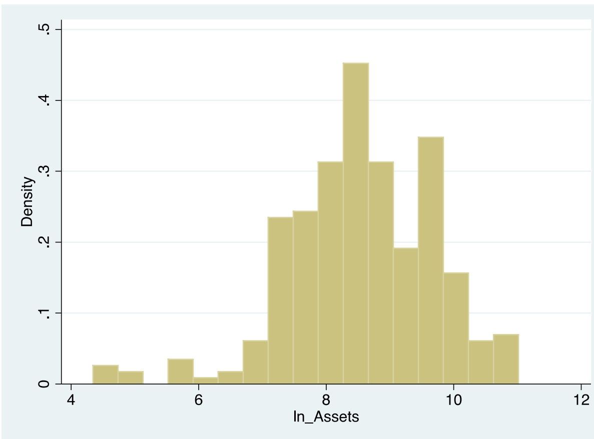

Panel B: *FixedIncome*



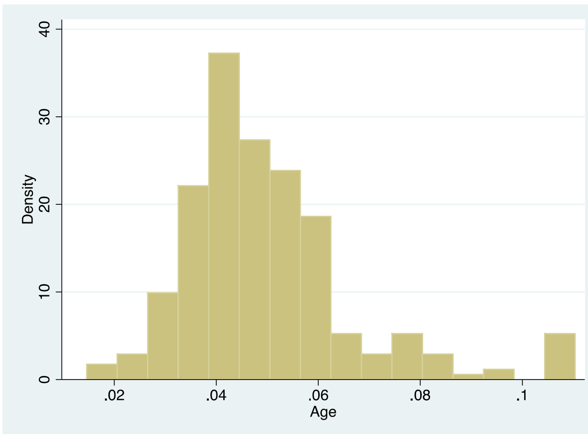

Panel C: *realEstate*




Panel D: *otherInvest*



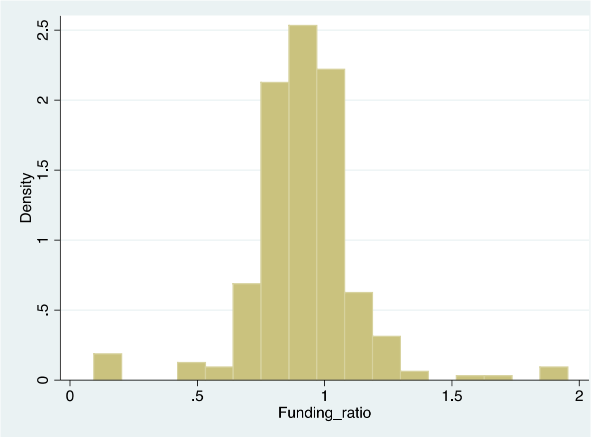

Panel E: *Size*



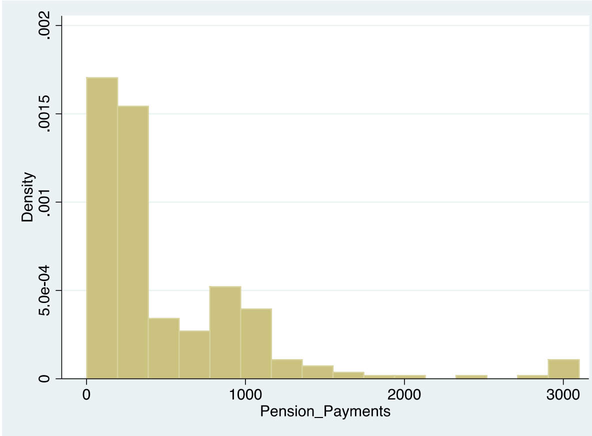

Panel F: *Age*

**Figure 6 continued.**

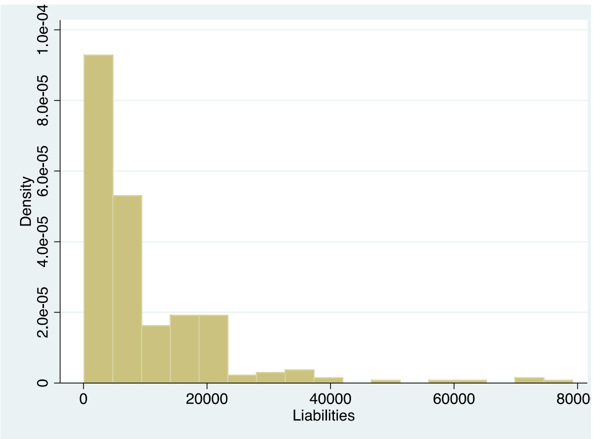
***Equity*:** Equity as percentage of total invested assets (%); ***FixedIncome*:** Fixed income as percentage of total invested assets (%); ***realEstate*:** Real estate as percentage of total invested assets (%); ***otherInvest*:** Other investments as percentage of total invested assets (%); ***Size*:** Total assets (x million $); ***Age*:** Pension payments scaled by total liabilities (ratio); ***FundingRatio*:** Total assets scaled by total liabilities (ratio); ***pensionPayments*** **:** Pension payments (x million $); ***Liabilities*:** Total liabilities (x million $). Data winsorized at the 99 percent level.




Panel G: *FundingRatio*




Panel H: *pensionPayments*



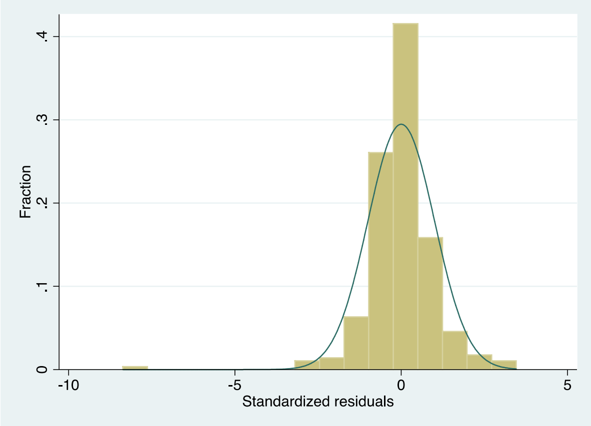

Panel I: *Liabilities*

**Table 18: Distributional tests for the regression of four different investment allocations on size, funding ratio and age.**

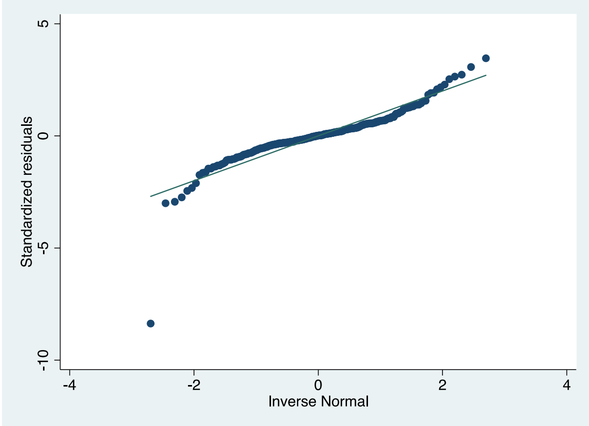
***Equity***: Equity as percentage of total invested assets (%); ***FixedIncome***: Fixed income as percentage of total invested assets (%); ***realEstate***: Real estate as percentage of total invested assets (%); ***otherInvest***: Other investments as percentage of total invested assets (%); ***Size***: Total assets (x million $); ***FundingRatio***: Total assets scaled by total liabilities (ratio); ***Age***: Pension payments scaled by total liabilities (ratio). Data winsorized at the 99 percent level. Standard errors are shown between parentheses. ***, **, * indicate significance at 1, 5, and 10% levels, respectively.

| *Model:* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Dependents:* | ***Equity*** | ***FixedIncome*** | ***realEstate*** | ***otherInvest*** |
| *Independent variables* | | | | |
| ***Size*** | 3.08698 | 2.59707 | -0.80190 | -5.18590*** |
| | (2.21426) | (2.28545) | (0.71142) | (1.02075) |
| ***FundingRatio*** | -3.33055 | -2.53956 | -0.11415 | 9.53164*** |
| | (5.40960) | (5.58353) | (1.74099) | (2.49799) |
| ***Age*** | 59.46048 | -73.54407 | 28.80968 | -61.83783 |
| | (84.60612) | (87.32634) | (27.19870) | (39.02495) |
| Constant | 16.85679 | 30.02269 | 4.83497 | 49.60687*** |
| | (19.53203) | (20.16001) | (6.27231) | (8.99957) |
| Fund dummies? | Yes | Yes | Yes | Yes |
| Year dummies? | Yes | Yes | Yes | Yes |
| Observations | 284 | 284 | 279 | 279 |
| R-squared | 0.854 | 0.894 | 0.927 | 0.914 |
| adj. R-squared | 0.8108 | 0.8630 | 0.9057 | 0.8883 |
| F-statistic | 19.9546 | 28.8530 | 43.4051 | 36.1008 |
| p(F) | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Heterosc Test: chi2(1) | 18.2444 | 7.7948 | 17.3867 | 34.1172 |
| Heterosc Test: P(chi2(1)) | 0.0000 | 0.0052 | 0.0000 | 0.0000 |
| Heteroscedasticity accepted? | Yes | Yes | Yes | Yes |
| Corrected for heteroscedastic errors | Not yet | Not yet | Not yet | Not yet |
| Shapiro-Wilk Normality Statistic | 8.0674 | 8.4877 | 6.4659 | 5.7668 |
| Shapiro-Wilk p-statistic | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Normality rejected? | Yes | Yes | Yes | Yes |

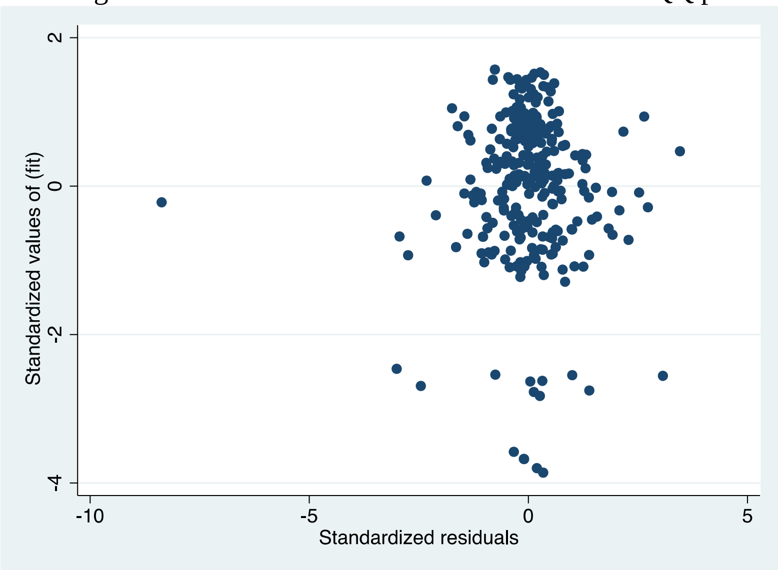
**Figure 7:** Plots of the regression residuals that were estimated during the main tests to detect heteroskedasticity and non-normality. The plots below are utilized on the residuals from the regression of $\boldsymbol{Equity}$ on the set of independent variables. The significance of the statistical tests is shown in Model (1) of **Table 18**.




a. Histogram of the residuals

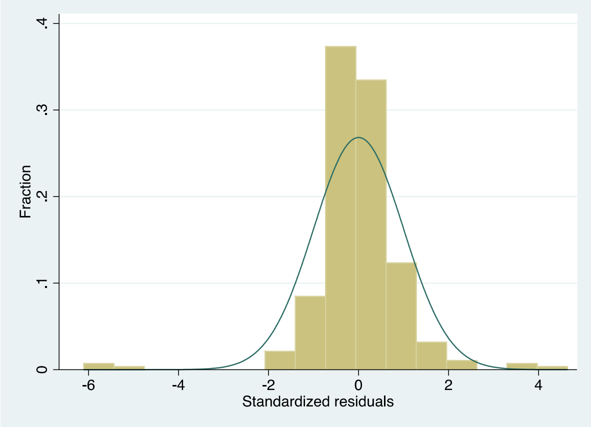



b. QQ plot of the residuals

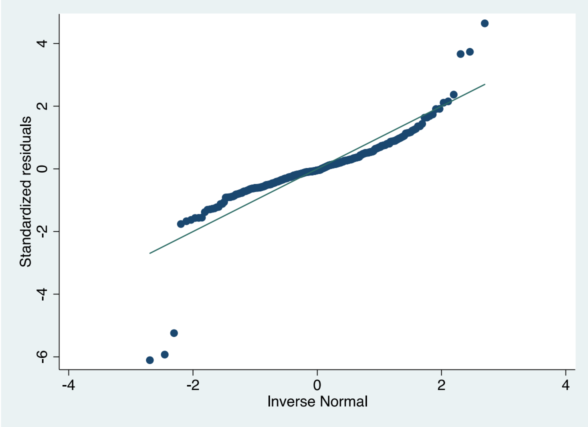



c. Scatter plot of standardized residuals and fit from the OLS regression with $LNtotalComp$ as the dependent variable.

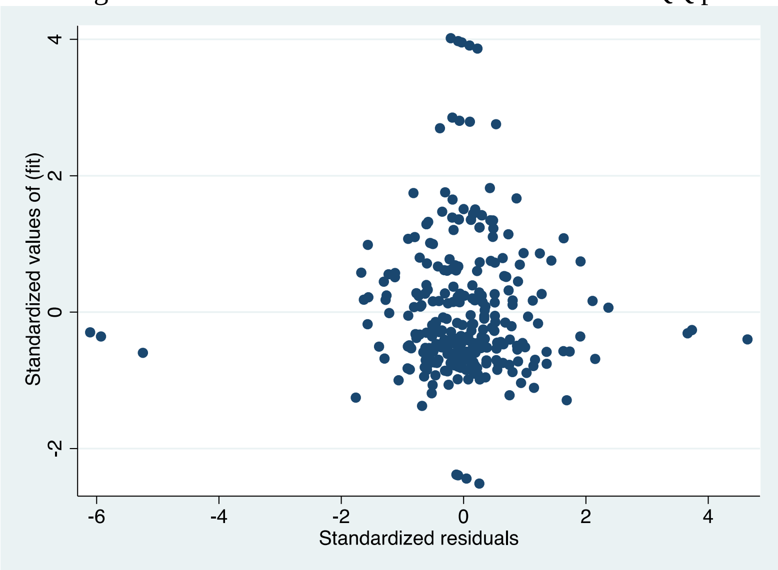
**Figure 8:** Plots of the regression residuals that were estimated during the main tests to detect heteroskedasticity and non-normality. The plots below are utilized on the residuals from the regression of $\boldsymbol{FixedIncome}$ on the set of independent variables. The significance of the statistical tests is shown in Model (2) of **Table 18**.




a. Histogram of the residuals

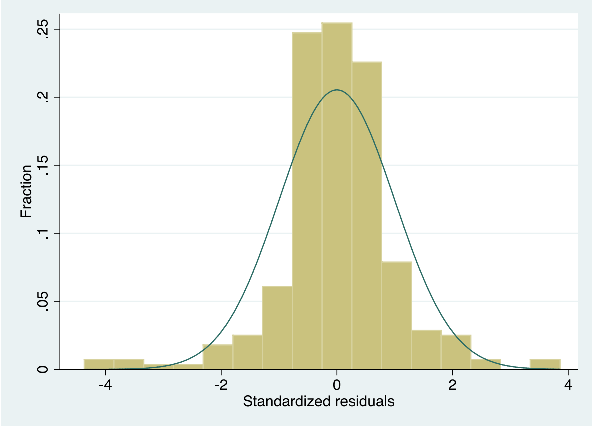



b. QQ plot of the residuals

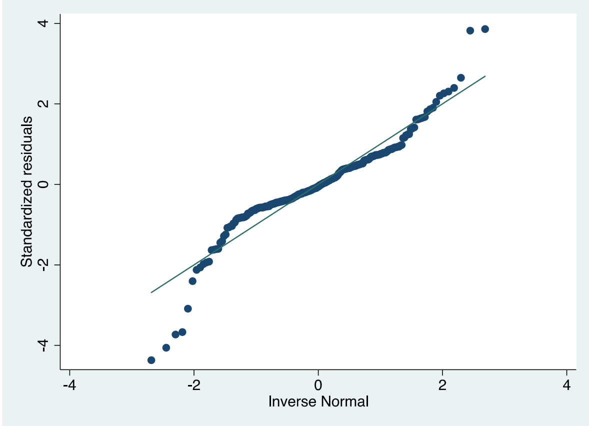



c. Scatter plot of standardized residuals and fit from the OLS regression with $LNtotalComp$ as the dependent variable.

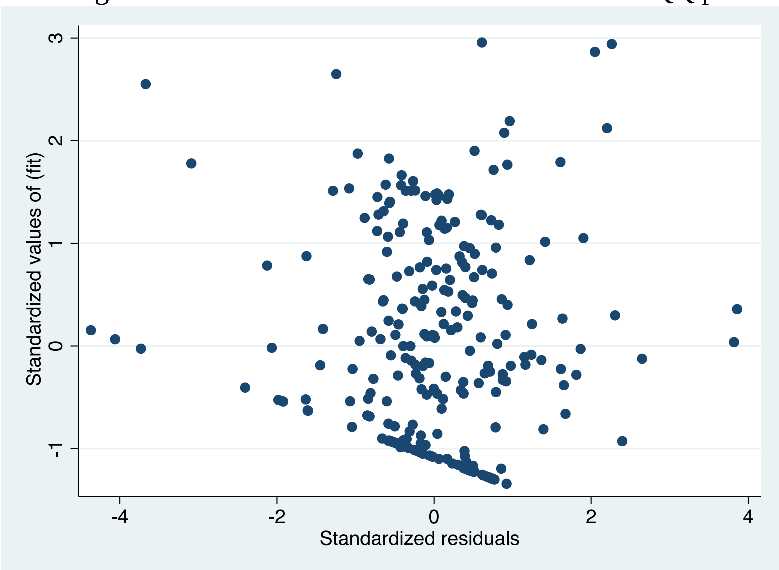
**Figure 9:** Plots of the regression residuals that were estimated during the main tests to detect heteroskedasticity and non-normality. The plots below are utilized on the residuals from the regression of $\boldsymbol{realEstate}$ on the set of independent variables. The significance of the statistical tests is shown in Model (3) of **Table 18**.




a. Histogram of the residuals

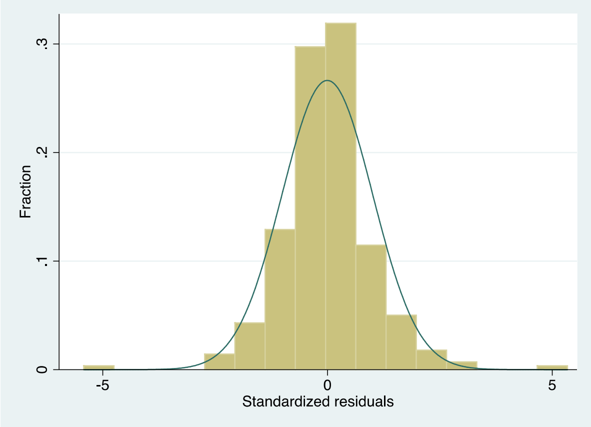



b. QQ plot of the residuals

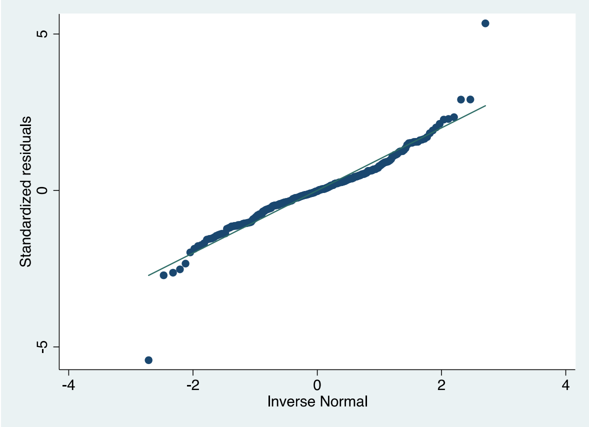



c. Scatter plot of standardized residuals and fit from the OLS regression with $LNtotalComp$ as the dependent variable.

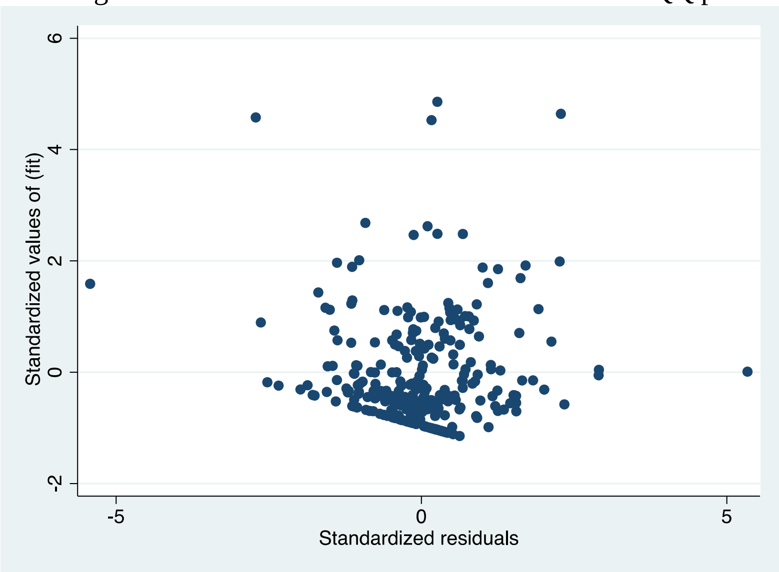
**Figure 10:** Plots of the regression residuals that were estimated during the main tests to detect heteroskedasticity and non-normality. The plots below are utilized on the residuals from the regression of $\boldsymbol{otherInvest}$ on the set of independent variables. The significance of the statistical tests is shown in Model (4) of **Table 18**.




a. Histogram of the residuals




b. QQ plot of the residuals




c. Scatter plot of standardized residuals and fit from the OLS regression with $LNtotalComp$ as the dependent variable.